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EDWARD A. SIMMONS, *President.* L. B. SHERMAN, *Vice-President.*
HENRY LEE, *Vice-President and Treas.* M. H. WIUM, *Secretary.*
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SAMUEL O. DUNN, *Editor.* ROY V. WRIGHT, *Managing Editor.*
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After many expressions of fear that the threatened strike situation would greatly reduce the attendance at the convention, the large number present yesterday was a pleasant surprise. Not only were many present from nearby points, but a considerable number were in attendance from places as far remote as New York and Los Angeles. Although the total registration of 289 yesterday was 84 less than that of the first day of last year's convention, it was larger than many had expected, in view of the uncertainty in the strike situation which existed until Monday morning. The important valuation hearing which opened at Washington on Monday morning has also kept a number of persons from this meeting and has served to still further reduce the attendance. In view of these conditions the number present yesterday morning was highly encouraging, and a heavy registration may also be expected today.

The Convention Attendance

President Baldwin's address at the opening of the convention touched upon the high regard with which the Manual is held by all who have to do with railway engineering, and of the duty with which the association is commissioned as a consequence. It is of the greatest importance that no material be inserted in the manual until all questions as to its correctness are removed. Conversely it would seem that once any matter has been included, it should not be withdrawn or replaced without equal deliberation. With the revision of the Manual a standing part of the work of all committees, there is some tendency to propose revisions of purely editorial nature, with no intent to make any material changes in the context. Under such conditions there is always a danger that some changes of meaning will occur that will not have received the proper degree of consideration by the convention. Also the time of the convention is taken for detail which a publication committee should handle.

Revision of the Manual

While the reports presented by the various committees this year bear evidence of an increasing realization of the importance of conciseness, there are still a number of ways in which they can be further condensed, and thereby made more generally available for the membership at large. One detail which may be omitted from a number of the reports without loss is the narration of the activities of the committees during the year. Few of the members of the asssociation are interested in knowing when and where the committees or the sub-committees met, or the names of those present, yet several of the committees have devoted a full page or more in their reports to this information. Its elimination will reduce the size of the proceedings 15 to 20 pages with benefit to all concerned. Another way in which reports of some of the committees can be improved is by greater condensation of the information contained in them. Prompted probably by the desire to make available for all of the members, the full information which

Editing Committee Reports

they may have collected, some of the committees have presented a large amount of data, which, while valuable in itself, is so voluminous as to lead most members to pass over it hurriedly. This defeats one of the principal purposes of committee work—the condensing of a large amount of information into a limited space, so that busy railway men may secure the information they desire quickly without the necessity of analyzing a large amount of data themselves. While there is a practical mean between the two extremes, it is safe to assert that most committees err on the side of too much information and, in some instances, actually make the report impractical for general use.

GET A BROAD VIEW OF THE EXHIBIT

It is not unusual for a railway man to come to the exhibit of appliances in the Coliseum with instructions to report on some one material or device which is receiving special attention at that time on his road. He knows that this exhibit furnishes the best opportunity of the entire year to get comprehensive information on any class of materials or devices used in maintenance of way or signaling, and he goes over the exhibits he is interested in with great care. As a result of such examinations definite recommendations have been made on more than one road with resulting benefit. This practice, however, has a tendency to focus attention on a small part of the entire show. If valuable conclusions for one road can be drawn on one class of exhibits, why cannot similar conclusions on several classes of exhibits be drawn which will be of value to many roads? The desirability of inducing railway men who go to this exhibit to broaden their view of it prompted the inauguration of our contest on what was learned at the exhibit.

This contest is being conducted jointly by the *Railway Age Gazette*, the "Railway Maintenance Engineer" and the "Railway Signal Engineer," all published by the Simmons-Boardman Publishing Company. It is divided into two main parts, one on maintenance of way and one on signaling exhibits. Prices of $50, $25 and $10, respectively, are offered in each of these main sections, and a single prize of $60 is offered for the best paper covering the exhibit as a whole. Any paper received which covers both maintenance and signal exhibits will be considered for the combination prize, and those that fail to win it will still be eligible for consideration in the two main divisions of the contest. It is understood that no individual will be awarded more than one prize. If the author does not specify whether his paper is primarily on maintenance or signaling, it will be placed in the group to which in the judgment of the editors it seems best suited.

The boards of judges, which will be made up of railway men, will make the awards on the following considerations: First, the practical value of the information which the writers present based on their study of the exhibit, and the extent to which the information will be of direct service to those who have not attended the display; second, the value of the suggestions offered to make the exhibit of greater benefit to railway men; and, third, the clearness and conciseness with which they cover the exhibit. In preparing these papers, it is desired that the writers treat devices and materials by classes rather than as the products of individual manufacturers, and that the names of companies be used only when necessary to make the meaning clear. The contest is open to anyone employed in railway service. Papers may be of any length, not exceeding 2,500 words. They should be mailed to the Editor of the *Railway Age Gazette*, 608 S. Dearborn street, Chicago, not later than April 9, 1917.

STANDARDIZATION OF SIGNS AND FENCES

The Committee on Signs, Fences and Crossings has given much attention to the standardization of roadway signs during the last few years. However, in spite of the excellent work which this committee has done, there is an almost entire lack of uniformity in the number and character of the signs installed on different roads today.

The one exception to this rule is the increasing uniformity in the signs at highway crossings, where many railways are following the standards adopted by the American Railway Association last year.

There is much merit in the contention of the committee that the number of roadway signs can be materially reduced without detriment. These signs are often designed to meet special conditions and their use is continued long after they have served the purpose for which they were installed. The average road can well afford to consider just how necessary the different signs are. In most cases it will be found that however necessary they may have been when installed, a considerable number of them now really serve no useful purpose, and that their removal will not only eliminate their cost of maintenance, but will also remove a possible source of confusion. There is not the same argument for uniformity of roadway signs for the exclusive use of railroad employees that there is for those at highway crossings for the guidance of the public, for the activities of any group of railway employees is in nearly all cases confined to one particular road and to the standards prevailing on that road. At the same time there is an advantage accruing with the universal use of standard signs.

Another valuable part of the report of this committee is the abstract of laws relative to the type of fence construction required by different roads. At the present time there is a lack of uniformity in these laws and the suggestion of H. R. Safford that this Association might be instrumental in securing the adoption of more uniform laws is important. At the present time a railway passing through 10 or 12 states may be required to maintain a different type of fences in each state, although in so far as local conditions are similar, it is self-evident that one type of fence will serve equally well in the different states. It should, therefore, be practical to prepare for adoption a series of standard fences, designed to meet local conditions, such as the range conditions of the west and those in the agricultural territories of the central states, in a manner which would be entirely practical.

BENEFITS FROM THE ASSOCIATION

That part of the report of the committee on Wooden Bridges and Trestles referring to timber and concrete trestles and the discussion it brought forth are good demonstrations of the need for and purpose of this association. Carried to its logical conclusion, the aim of the association implies not only a standardizing of practice but a unifying of policy as well. In too many cases we still find railways in the same general territory following entirely different practices as to design and materials used in structures of various kinds, when if the conclusions reached in the course of the conventions of the association are correct, these roads ought to change their practices if they are to conduct their construction and maintenance activities with the greatest degree of ultimate economy.

It does not follow necessarily that one form of construction is wrong and another right. Rather each may have its place and if proper considerations are taken into account in determining upon the designs to be used, each type would be applied where it was most suitable. Using trestle construction as an example, we

find that many railroads have built reinforced concrete trestles for years, while others have not even a single example of it on their lines. Some use the concrete piles for the substructure of these trestles, while others make extensive applications of the solid concrete pier construction. Having once established the use of a certain design, the tendency is to search for further justifications for its continuance rather than to modify practice by applying the experience of others.

These conditions are explained to a considerable extent by the fact that in so far as ballast deck trestles are concerned many engineers have considered both timber and concrete ballasted trestles were in an experimental stage and they have preferred that someone else do the experimenting. This period is now drawing to a close and it is fitting that conclusions be drawn on the experience secured thus far with these structures. Once definite rules are estabilised to the satisfaction of the association to govern the selection of the most suitable structure, they will not serve any useful purpose unless they are put into practice. Railways will not derive the greatest good from the association if they adhere to their present standards to the entire exclusion of the association's findings.

TRACK COMMITTEE MEETING

H. R. Safford, vice-chairman of the Track Committee, has called a meeting of that committee in the Florentine room for 8:45 this morning.

A. R. E. A. DINNER

Those desiring tickets for the banquet this evening should secure them before noon today from W. A. Wallace of the Arrangements committee, at the office of the secretary, room 1166, Congress Hotel. With the large number of tickets purchased yesterday it is desirable that those planning to attend make arrangements as soon as possible.

LARGE ATTENDANCE AT THE COLISEUM

The representatives of the supply concerns at the Coliseum were much impressed by the large attendance of railway men at the exhibit yesterday. The building was well filled throughout the day with railway men, who examined the exhibits in detail. From present indications this year's display is one of the most valuable from the standpoint of the manufacturers which has ever been held.

RUSSIAN BUYERS AT THE COLISEUM

G. Sparre-Ulrich, manager of the technical department of the Russian Trading Company of Petrograd and Moscow, and Charles F. Pierce of Arthur Van Sicklen & Company, Inc., New York City, visited the Coliseum yesterday, examining the exhibits with particular reference to Russian requirements. They found much of interest and value in their examination of American railway devices and expressed themselves as much impressed with the display.

PLEASE ACCEPT OUR APOLOGIES

For the benefit of the newer members of both the American Railway Engineering Association and the National Railway Appliance Association, as well as other readers of the Daily Railway Age Gazette, we wish to call attention to the fact that the name of P. C. Jacobs was interchanged with that of E. E. Hudson and that a similar transposition was made in the names of J. Alexander Brown and M. J. Trees under the photographs of officers of the National Railway Appliances Association in yesterday's Daily. The faces of these gentlemen are so well known to the older members of the associations that they promptly detected the mistake.

BRIDGE AND BUILDING ASSOCIATION MEETING

The executive committee and a number of other members of the American Railway Bridge and Building Association will meet in the Congress hotel at 4:30 p. m. this afternoon, to discuss the work of this association. A number of important subjects are to be considered, including arrangements for the next annual convention, which will be held in St. Paul in October.

TODAY'S PROGRAM

The convention will be called to order at 9:30 this morning; the afternoon session will open at 2 p. m.

V.	Track	Bulletin 193
II.	Ballast	Bulletin 193
III.	Ties	Bulletin 193
I.	Roadway	Bulletin 194
XX.	Uniform General Contract Forms	Bulletin 194
XVI.	Economics of Railway Location	Bulletin 194
XIV.	Yards and Terminals	Bulletin 194
XI.	Records and Accounts	Bulletin 194
VI.	Buildings	Bulletin 194

Annual Dinner at 6:30 P. M.

THE ANNUAL DINNER

The annual dinner will be given in the Gold room of the Congress Hotel this evening, beginning promptly at 6:30. The following addresses will be made: Sir William Peterson, principal of McGill University, Montreal, Quebec, on "Sister Democracies;" Professor William H. Thornton, of the University of Virginia, University, Va., on "The Basis of Professional Ethics for Engineers," and Samuel O. Dunn, editor, *Railway Age Gazette*, on "The Interest of Private Property in Railway Regulation."

C. E. SMITH AWARDED THE CROES MEDAL

C. E. Smith, consulting engineer, St. Louis, Mo., and president of the American Railway Bridge and Building Association, has just received the J. James R. Croes gold medal of the American Society of Civil Engineers. This medal, which is awarded for the second most meritorious paper presented during the year, was the result of the presentation by Mr. Smith of the history of the Little Rock Junction bridge of the Missouri Pacific-Iron Mountain System over the Arkansas River at Little Rock in 1916.

ADDRESS ON SAFE WALKING SURFACES

H. W. Mowery, a member of the National Safety Council, the American Society of Mechanical Engineers and of the American Society of Safety Engineers, will give an illustrated talk on "Safe Walking Surfaces" in the Florentine room at nine o'clock this morning, under the direction of the Committee on Buildings. Mr. Mowery has made an extended study of this subject, which is one of much importance to railway engineers, owing to the large number of casualties which are resulting at present from unsafe walking surfaces.

The A. R. E. A. Convention in Session

Railway Engineering Association Proceedings

Tuesday's Sessions, Including the President's Address and Several Committee Reports and Discussions

THE eighteenth annual convention of the American Railway Engineering Association was called to order in the Florentine Room of the Congress Hotel at 9:30 yesterday morning by President A. Stuart Baldwin, chief engineer of the Illinois Central. The convention room was well filled at the time the meeting was called to order and many other members and guests registered during the day. The reading of the minutes of the last meeting was dispensed with and the convention passed to the President's address.

Address of President A. Stuart Baldwin

THE work of this association during the year that has passed since we last assembled in this auditorium has proceeded with diligence, and with marked success on the part of the committees. The reports exceed in volume the output of any other year by 25 per cent, and the quality of the work of the committees will stand as marking another milestone in the life of this association with distinction in professional advancement.

The membership of the association shows a net increase of 34 in numbers, the addition of 142 new members having been offset by an unusual number of deaths and resignations. The general growth in membership has been steady, but slow, the number for the five years past having increased from 1,030 to 1,370, or 33 per cent. It may be interesting, in this connection, to compare the membership of the association with four of the other national engineering societies, and with their rate of growth during the same period. These stand:

	Present Membership.	Increase in Five Years.
American Society of Civil Engineers.....	8,192	29 per cent
American Society of Mechanical Engineers....	7,704	87 per cent
American Institute of Electrical Engineers....	8,350	13 per cent
American Railway Engineering Association....	1,370	33 per cent

This comparison is not intended to be invidious, but suggestive. We have not the number to draw from that those societies not so specialized and which call upon the profession at large; but there are many men of high standing in railroad engineering circles, and particularly among consulting engineers and in our institutions of learning who are not members that should be with us.

The affairs of your association are upon a very substantial basis financially, there being an investment of $25,574.57 in high-grade securities, with a working fund of $5,234.81, and a normal surplus of about $3,000 per year. It is here suggested that it should be the policy of the association to use the sum invested as a nest egg, allowing the interest to compound and adding to it annually as occasion justifies, with a view of securing at some future date a permanent home with a well-equipped library and committee and assembly rooms.

This association could, through its committees, expend large sums of money in research work of various kinds, but, inasmuch as it is a body supported by the voluntary subscriptions of its members, the surplus saved from subscriptions or publications should be invested for the benefit of the association proper, and funds required for research work should be contributed by the railroads or the other great corporations directly benefited.

Considering it advisable to determine the extent to which recommendations in the manual as to specifications and standards are being made use of, a circular letter was addressed to heads of engineering departments of the railroads represented in the association. The replies were gratifying, many of the department heads going into the use made of the manual in great detail. From an analysis of the replies, it is shown that the standards and specifications are exerting a very powerful influence toward a general unification of practice. Many of the recommendations of the manual are being adopted literally, others with changes to suit local conditions or individual ideas and to a very great extent they are being used as an aid and guide. It is of great importance that

the chairmen of committees should fully realize their responsibility for the maintenance of a high standard for the material going into the manual. It embodies in a small scope, but to a great extent the net results of the labors of the association, and should be carefully guarded. As an example of what may be accomplished in this direction may be cited the wide use of the specifications for Steel Railway Bridges of your Committee on Iron and Steel Structures. Not only have these specifications been widely adopted in this country, but we are advised that they were so highly thought of by the Argentine Republic that they have been translated into Spanish and published in the official bulletin of the department of public works of that country.

The General Index, so long in preparation, is now with the Committee on Publications, which is reporting progress, and promises it will be ready for distribution in a few months.

The Joint Committee on Stresses in Railroad Track has made a progress report which appears in Bulletin No. 193 for January. Since the last annual report the committee for soliciting contributions has succeeded in obtaining contributions aggregating $7,500 from the Bethlehem, Cambria and Lackawanna steel companies, each contributing $2,500. The profession is to be congratulated upon securing this sum for the continuation of research work in a field in which we have very little definite data. Under the leadership of Prof. A. N. Talbot, this association and the American Society of Civil Engineers can expect some exceedingly creditable results from the work of this committee.

A. STUART BALDWIN
President

Probably at no time in the history of the country has the labor situation been in so precarious and uncertain a condition. The problem confronting the railroads for both construction and maintenance is involved not so much in securing appropriations or in getting materials, as in actually finding the number of men to carry on the work that is authorized. A number of northern railroads have agents in the South procuring negro labor and the South is being deprived accordingly. Mexicans are being brought into the country in considerable number, but there is really no supply in sight sufficient to meet the demand and it behooves the railroads to go about their work as quickly as possible, as there is promise of an unprecedented competition for labor as the season advances.

Railway Construction

During 1916 the gross receipts of the American railways were the greatest in their history, and the average receipts per ton mile of freight handled the lowest in nearly 30 years. It is a most significant fact that during this same year and in 1915 there was a smaller mileage of new lines constructed than in any year since railroad expansion started on any considerable scale. Taking the 43-year period from 1870 to 1913, the average miles of line constructed per year was 4,725, the greatest mileage in any year having been 12,876 in 1887.

The period of our greatest railroad expansion has doubtless passed, but in 1915-16 the average was less than 1,000 miles per year. The explanation of this phenomenal condition would seem to be that so greatly have the rates been reduced, and so harrassed have the railroads been by Federal and state legislation that the railroads are feeling their way along, as it were, spending surplus where they have it, in the betterment of existing lines, the purchase of heavier power, and other methods that may prove a salvation to them in reduction of operating expenses, if greater stress may come upon them, rather than in expending in mileage and thereby bringing in increased responsibilities. Capital will not be forthcoming for new lines as long as such conditions exist, and in the meantime there are many great areas of land in this country awaiting development.

From time to time certain subjects have been assigned to this association by the American Railway Association. As is well known, the work of the Rail committee has been largely financed by that association, it having contributed since 1910 sums aggregating nearly $50,000. As a result of this work rail sections for 90-lb., 100-lb., 110-lb. and 120-lb. have been adopted by this association and their general use is increasing. Specifications for carbon steel rails have been recommended; likewise for high carbon, heat treated joint bars and track bolts. The collection of rail failure statistics by all the railroads is being systematized and summarized and rail failures are being related to the process of manufacture in a manner that is helpful. Recently there has been referred to this committee the subject of frictionless rails, with request for report as to the extent of the use and the results obtained therefrom. This is now under investigation.

The addition of $10 per ton in the price of rails adds a heavy tax to the operating costs of the railroads. On the basis of 3,000,000 tons of rails as used last year in this country, this item alone increases the expense of the railroads $30,000,000. When to this item are added the enormously increased costs of labor and service in every form, and supplies of every character, it can be readily seen that a sudden decline in business might result most disastrously to many of the railroads, before a readjustment of rates or expenses could be made.

The subject of contour of chilled car wheels, with throat clearances for frogs, guard rails, etc., has been assigned by the American Railway Association and referred to the Track committee. The matter of clearance, which is a more than usually important one at this time, on account of prospective federal legislation, has been under consideration jointly by the committees on Rules and Organization and on Electricity. A committee composed of four members of this association has been cooperating with a committee of the American Railway Association in presenting the matter before the Congressional committee that is handling the matter.

Co-ordination of Work of Voluntary Associations

Under date of October 30, 1916, a letter was received from L. F. Loree advising that he, with Julius Kruttschnitt and Daniel Willard, has been appointed by the Executive committee of the American Railway Association as a sub-committee to report upon the question of co-ordinating the various voluntary railway organizations with the A. R. A. The action contemplated is the classification of this association as the primary mainte-

nance of way and structures association in the country, with other associations, such as the Railway Signal Association, the Roadmasters' and Maintenance of Way Association, the Association of Railway Electrical Engineers, the American Railway Bridge and Building Association, the Railway Gardening Association, the Railway Fire Protection Association, the Maintenance of Way Master Painters' Association, the Railway Tax Men's Association, the Railway Real Estate Association, the American Electric Railway Association, and the American Wood Preservers' Association. The idea in general is to perfect an organization leading directly to the American Railway Association as the ultimate authority. The proposal was the subject of extended discussion at a meeting of the Board of Direction last December, as a result of which the presidents of the associations mentioned were addressed. The answers were almost entirely favorable to the proposition and a meeting of the presidents or representatives of all of the organizations will be held this evening, as a result of which a committee will probably be appointed to work out the details of the proposed arrangement. Before any organization is suggested, however, the matter will be referred to the individual members of the association for a vote, as it is one affecting the constitution. The subject should be given very careful thought, as it may materially affect the future of this association.

Electric Traction

The only material advance in the mileage of electrified steam railways during the past year is on the part of the Chicago, Milwaukee and St. Paul, that company having completed the installation of and put into operation an additional section about 450 miles in length. A few years ago the demand on the part of the public for electrification of steam railways was more insistent than at present. It is becoming recognized that the cases in which steam railroads are justified financially in electrifying are exceptional; that in the present state of the art it is only where unusual conditions prevail that the change from steam to electric traction is justified, such as, for instance, the necessity for the elimination of smoke from tunnel operation; the requirements for the expansion of business in congested districts; exceptional possibilities of economical power production, whether by fuel or water, or an unusual combination of excessively heavy traffic with high gradients. It has been further proven that the proportionate responsibility of railroads in large cities for the smoke nuisance has been greatly exaggerated. The admirable report of the Association of Commerce in Chicago, through its Committee on Smoke Abatement and Electrification of Railway Terminals, of which Dean W. F. M. Goss was the chairman, has undoubtedly been of great influence in bringing thoughtful men to a realization of the principles involved, and a saner view is beginning to prevail.

Federal Valuation

The valuation work being done under the direction of the Interstate Commerce Commission is making substantial progress. During the year ending October 1, 1916, approximately 51,000 miles of road, or 77,000 miles of track, have been inventoried in the field. If the same rate of progress is maintained in the future as during the past year the commission's field inventory will be practically completed about January 1, 1920.

The ascertainment of prices presents a very much more intricate problem than securing the field inventory. To guide the commission in fixing prices for each unit of property various valuation orders have been issued requiring the carriers to make most exhaustive analyses of construction costs on lines of railroad and projects carried out during the past 15 years. The compliance with the valuation orders and special requests of the commission is involving the carriers in much greater cost than was at first anticipated. The analyses of costs will serve to guide the commission in the application of prices to units of work, and likewise put the carrier in possession of cost data which will be useful in determining the reproduction cost of the property, and also throw light on its value.

It has been found necessary for carriers in certain sections of the country to make extensive studies of local conditions. This is peculiarly applicable to large railroad centers, where many complications arise on account of the carriers' properties being adjacent to and crossing each other, and occupying land of very great value. These local studies are being carried out by special organizations of the carriers and it is only through the use of such studies and analyses prepared by the carriers at great cost that the reproduction cost and value of terminal properties can be properly ascertained.

The tentative valuations already filed by the Division of Valuation, covering to date 2,860 miles of railroad, indicate the attitude of the commission on the disputed vital principles of valuation. The protests of the carriers now in course of hearing are developing the differences existing between the parties at interest. The decisions made after these hearings are concluded will have an important bearing on the determination of the values of railroad properties.

The Interstate Commerce Commission has made a ruling that the fiscal year for railroad reports shall be made to close on December 31 instead of June 30. The advantage of discontinuing the closing of accounts during the middle of the working season has been dwelt upon at length by this association through the work of the Track committee. The efforts in behalf of this very desirable change have doubtless been of marked influence in bringing it about.

National Conditions

To close without reference to the situation of our country in connection with the possibilities of war and the necessity for preparation therefor, would leave untouched upon what may prove at an hour's notice, a matter of paramount, or indeed vital importance to the railroads. As the course of events during the past years that the nations of Europe have been at war are reviewed, more and more, in spite of its strenuous endeavors to remain neutral, have the interests of this country become involved, and, despite the determined purpose of the President to avoid it, the more does the sequence of events appear to be dragging the United States into the vortex.

To what extent are the railroads of the country prepared for such a contingency? Ex-President Taft, in a speech delivered in Baltimore on February 22, stated: "The inadequacy of our railroad system to meet the demands of our rapidly increasing population and the volume of transportation that our foreign trade demands, and to meet the requirements of a state of war, *which we face*, is startling. We have had many warnings from railroad men as to what would occur under conditions like the present. Their warnings are now being vindicated. The embargoes which the railroads have been obliged to impose on legitimate shipments are a mathematical demonstration of how far short is our arterial system of interstate commerce." Such a statement is indeed startling, but must none the less be recognized as containing the exact truth. It is alleged that the organization and transportation of 150,000 troops to the Mexican border, required about six weeks, whereas Germany and France had several millions of men assembled

on their frontier within eight days, and Switzerland threw 400,000 troops to her borders within 24 hrs. Our country is rapidly awakening to the importance of this matter.

We cannot know when, if at all, the crucial test may come, nor can anyone surmise what sections, if any, may be called upon to bear the heat of conflict, but it behooves the engineering departments of the railroads to inform themselves regarding the possible requirements so as to be prepared to meet any conditions that may arise. Engineers who are eligible should be encouraged to join the engineer officers' reserve corps, and the requirements of the service in case of a war should be the subject of study and conference as an operating feature of railroads.

A change is rapidly coming over the spirit of our dreams and no longer may we hug to our bosoms the delusive phantom of our one-time splendid isolation. Distance has been annihilated, the air is navigated and the depths of the oceans are available. The claim that because of our isolation we could avoid entangling alliances with foreign countries was logical for a former day and for a nation in the making, but this country has become an adult, yea, a giant among nations, and must take her seat in the Council Chamber of the mighty. No more can she withhold her power and influence for righteousness from the nations than can good men withhold their influence from the councils of their country. The time has come for a new and an international declaration of independence—that all *nations* are created free and with equal rights to life, liberty and the pursuit of happiness; that the weak among the nations shall be protected from the tyrant and the oppressor; that nations which are incapable of self-government must be aided and controlled until they can stand alone, and that government must be of the nations, for the nations and by the nations. If this country is to take its place, as it inevitably must sooner or later, in such a hegomony of nations, it must come strong armed and well prepared. This preparedness must prevail through every station of life, and the railroads will be one of the greatest factors to be considered in this great movement. Of one thing we may be sure, and that is that in no profession, in no department of life and service will be found more zeal, more loyalty to flag and country and more intelligent service than will be produced from the members of your association when properly trained and equipped for the task.

Report of the Board of Direction

The following report relating to the affairs of the association for the past year is submitted for the information of the members:

Membership

Number of Members last Annual Report		1,336
Admitted during the year	142	
Deceased Members	16	
Resigned	38	
Dropped	54	
	108	108
Net increase during the year	34	34
Total Membership		1,370

The losses by death during the year were as follows:

Virgil G. Bogue	Charles C. Hill
T. E. Calvert	C. W. Hotchkiss
C. H. Cartlidge	W. E. Hoyt
E. L. Corthell	E. M. Jessup
O. H. Crittenden	Theo. Mackrell
W. A. Gardner	Curtiss Millard
F. D. Griffin	Jos. O. Osgood
R. L. Hazelgrove	T. E. Wickham

Monographs

An unusual number of interesting monographs have been issued under our auspices during the past year. A list of the special papers is given below:

"How to Calculate Fuel Consumption," by John G. Sullivan, Chief Engineer, Western Lines, Canadian Pacific Railway.
"Power Input for Movable Bridges," by B. R. Leffler, Engineer of Bridges, New York Central Railroad, Lines West.
"Discussion on Impact," by L. N. Edwards, Supervising Bridge Engineer, Department of Public Works, Toronto, Canada.
"Service Tests of Treated and Untreated Fence Posts," by Harlow Bradley, Assistant Engineer, Forest Products Laboratory.
"Segregated Streaks in Steel Rails," by George F. Comstock, Physical Testing Laboratory, Titanium Alloy Manufacturing Company.
"Test of Rail Joints," by H. B. MacFarland, Engineer of Tests, Santa Fe Railway System.
"Cost of Railroad Transportation, Railroad Accounts, and Governmental Regulations of Railroad Tariffs," by the late Albert Fink (contributed by W. H. Courtenay).
"Sub-Drainage of Wet Cuts with Vitrified Tile on Missouri Pacific Railway," by W. C. Curd, Drainage Engineer, Missouri Pacific Railway.
"Specifications for Frogs, Switches, Crossings and Slip Crossings, Pennsylvania Lines," by W. C. Cushing, Chief Engineer Maintenance of Way.
"List of References on Valuation of Steam Railways," by Bureau of Railway Economics, Washington, D. C.
"Punched-Out Track Signs on the Canadian Pacific Railway," by J. W. Orrock, Principal Assistant Engineer, Canadian Pacific Railway.
"Passenger Train Resistance," by Prof. Edward C. Schmidt, Professor of Railway Engineering, University of Illinois.
"Induced Interior Transverse Fissures in Rails," by Dr. P. H. Dudley, Consulting Engineer, Rails, Tires and Structural Steel, New York Central Lines.
"Improvement in Method of Casting Ingots," by W. C. Cushing, Chief Engineer Maintenance of Way, Pennsylvania Lines.
"Rail Tests—Quick Bend Method," by W. C. Cushing, Chief Engineer Maintenance of Way, Pennsylvania Lines.

Financial Statement for Calender Year Ending December 31, 1916

Balance on hand January 1, 1916		$13,880.40
Receipts.		
Membership Account		
Entrance Fees	$ 1,350.00	
Dues	7,768.00	
Subscriptions to Bulletin	7,768.00	
Binding Proceedings and Manual	1,202.00	
Badges	42.00	
Sales of Publications		
Proceedings	2,077.80	
Bulletins	946.41	
Manual	2,479.86	
Specifications	166.45	
Leaflets	401.55	
Advertising		
Publications	15,652.11	
Interest Account		
Investments	756.42	
Bank Balance	124.28	
Annual Meeting		
Sales of Dinner Tickets	1,420.50	
Miscellaneous		
Impact Test Fund (N. & W. Ry. Co.)	1,000.00	
Sundries	38.46	
American Railway Association		
Rail Committee	5,933.75	
Total		$49,127.59
Disbursements.		
Salaries	$ 5,675.25	
Proceedings	4,646.23	
Bulletins	4,793.16	
Manual	2,637.99	
General Index	200.00	
Miscl. Stationery and Printing	850.89	
Rents	1,064.96	
Light	28.30	
Telephone and Telegrams	129.71	
Equipment	115.70	
Supplies	305.26	
Expressage	639.97	
Postage	961.93	
Exchange	65.71	
Audit	621.25	
Committee Expenses	65.37	
Commission on Advertising	619.80	
Impact Tests on Electrified Railways	463.55	
Contribution to Joint Committee on Concrete	250.00	
Annual Meeting Expenses	2,034.43	
Miscellaneous	213.35	
Rail Committee	5,815.80	
Total		$32,198.61
Excess of Receipts over Disbursements		$16,928.98
Balance on hand December 31, 1916		$30,809.38

Stresses in Track Fund

Balance on hand January 1, 1916		$ 7,065.28
Received from Interest during 1916		156.31
		$ 7,221.59
Disbursements during 1916:		
Committee Expenses	$ 16.44	
Salaries	2,534.09	
Transportation	173.80	
Hotel and Meals	159.85	
Supplies	174.07	
Postage	10.00	
Expressage	18.18	
Telegrams	3.30	
Equipment	5.50	
Total Disbursements		$ 3,095.23
Balance of fund on hand in Standard Trust & Savings Bank, December 31, 1916		$ 4,126.36

Respectfully submitted,
Board of Direction.

Report of the Treasurer

Balance on hand January 1, 1916		$13,880.40
Receipts during 1916	$49,127.59	
Paid out on audited vouchers during 1916	32,198.61	
Excess of Receipts over Disbursements		$16,928.98
Balance on hand December 31, 1916		$30,809.38
Consisting of:		
Four St. L. & S. W. Ry. Co. bonds	$ 3,319.31	
Two L. S. & M. S. Ry. Co. bonds	1,886.75	
Four North West. Park Dist. bonds	4,062.00	
Eleven City of Chicago Special Assess. Imp. bonds	6,011.51	
Five Chicago Union Station Co. bonds.	5,000.00	
Six Kansas City Term. Ry. Co. bonds.	5,295.00	
Cash in Standard Trust & Savings Bank	5,209.81	
Petty Cash Fund in Secretary's Office.	25.00	
	$30,809.38	

Stresses in Track Fund

Balance on hand January 1, 1916	$ 7,065.28
Received from Interest during 1916	156.31
Total	$ 7,221.59
Paid out on audited vouchers during 1916	3,095.23
Balance of fund on hand December 31. 1916	$ 4,126.36

General Balance Sheet

December 31, 1916.

Assets.

Dues from Members	$ 1,792.85
Due from Sales of Publications	1,609.90
Due from Advertising	700.00
Due from Am. Ry. Assn. (Rail Committee)	416.66
Furniture and Fixtures (cost)	997.40
Gold Badges on hand (51)	76.50
Publications on hand (estimated value)	5,000.00
Extensometers, etc. (estimated value)	500.00
Investments	25,574.57
Interest on Investments (accrued)	26.26
Cash in Standard Trust & Savings Bank	5,209.81
Petty Cash Fund in Secretary's Office	25.00
	$41,928.95

Liabilities.

Members' Dues for 1917 paid in advance	$ 3,329.50
Impact Test Fund on Electrified Railways	536.45
Surplus	38,063.00
	$41,928.95

The President: I wish to call the attention of the members to the National Railway Appliance Exhibition being held as usual in the Coliseum. That exhibition is one of the valuable educational features of this meeting, and I think appreciation should be shown of it by our members in going to see it. It is always an exceedingly interesting feature and an exceedingly instructive one, and the officers of the National Railway Appliance Association have shown a very great appreciation of a proper recognition on our part of what was one of the great functions of that exhibition, and that is the education of the railroad engineer.

In addition to the remarks made in the annual address with reference to the manual, I wish to dwell to some extent upon the importance of the members watching that jealously, guarding it well to see that it represents what it should so far as the action of this association is concerned, that it be in every respect the high-grade publication that it should be, coming from such an association as this. You gentlemen may remember that Mr. Walter C. Berg, in his lifetime, very carefully watched it to see that at all times it was as free as possible from mistakes, and he was quick and ready to detect any errors of faulty diction that were likely to go into it. Mr. Cushing has since then done much the same class of work. I will read an extract from a letter he wrote me on the subject:

"In looking over the manual in connection with the proposed outline of work for 1917-18, I have found a great many cases where the arrangement is quite poor and where a little more study on the part of the committees would fill in gaps in certain information, which would make a more complete and connected whole. I think it is important to impress upon every chairman of a committee that his section of the manual is under his special guardianship and that it should be the effort of his committee to make that portion of the manual as complete and thorough as possible and have it in the best order and arrangement possible. I do not think the chairmen of committees study the manual sufficiently with that object in view. The care of the manual in all of those respects is entirely too great a task for one or two members, but the work should be systematically looked after by the chairmen of committees and kept right up to date."

Report of Committee on Signals and Interlocking

THE following subjects were assigned:

1. Make critical examination of the subject-matter in the Manual, and submit definite recommendations for changes.

2. Continue the study of economics of labor in signal maintenance.

3. Report on the problem of signaling single track roads with reference to the effect of signaling and proper location of passing sidings on the capacity of the line.

4. Report on specifications adopted by the Railway Signal Association, which, in the judgment of the committee, warrant consideration, conferring with Committee on Track on any appliance affecting track.

J. A. Peabody, Chairman

5. Report on requisites for switch indicators, including method of conveying information as to the condition of the block to the conductor and engineman.

6. Report on the desirability of having an overlap in automatic signaling; if so, is it best to have two stop indications between trains or two caution indications instead, or the latter in special cases only, such as down-grade tracks?

7. Report on the various methods of giving signal indications other than by means of the semaphore (this includes the light signal for day and night indication).

8. Report on the feasibility of separating into distinct types of their own (1) the signals for train operation, and (2) the markers or signs which indicate the location or position, or both, of information signs and switch signals for conveying information to trainmen: (1) The semaphore is now almost universally used for governing train operation; therefore (2) Design suitable day and night (if necessary) markers or signs for switch signals, derail switches, stop posts, slow posts, resume-speed posts, water station and track-pan markers, highway crossing signals, etc., conferring with Committee on Signs, Fences and Crossings.

9. Analyze the signal schemes which have been presented to the Association. State specifically for what purpose each aspect and indication shall be used and what action on the part of the engineman is required. (See report of American Railway Association, November 17, 1915.)

10. Report on automatic train control.

11. Report on the comparative merits in various locations of alternating current and direct current for operation of automatic signals.

12. Report on applications of aspect for instructions to trains to take siding at a non-interlocked switch.

These subjects have been assigned to various subcommittees.

(1) No revisions of the manual were recommended.

(2) The committee submitted a preliminary report on the economics of labor in signal maintenance in 1914 and in 1915, a report which it requested should be accepted as information. It considers that these reports covered the subject and recommended that the subject be considered closed.

(3) The committee presented a second installment by F. L. Dodgson, consulting engineer, General Railway Signal Company, of an analysis of the effect of passing track locations on the capacity of single-track, as a progress report, for the information of the members. Further work on this subject will be in applying and testing the formulas or methods on pieces of roads with their actual movements of trains.

(4) R. S. A. Specifications

The committee submitted the following list of matters acted upon by the Railway Signal Association at its convention in 1916 and adopted by letter-ballot in 1917:

Text

Battery, Storage:
Charging equipment.
Composite type, stationary, for signaling (Specifications).
Lead type, portable for signaling (Specifications).
Cables:
Aerial aluminum steel reinforced cable (Specifications).
Conduits:
Installation of Fiber and Metal Systems (Specifications).
Interlocking:
Electro-mechanical (Specifications).
Wires and Cables:
Definitions of principal terms.
Aerial aluminum steel reinforced cable (Specifications).

Drawings

Carriers, transverse pipe....1073
Compensator, link....1017
Crank stand, two-way separate pin horizontal....1393
Elevators, battery....1227
Foundation, ground mast bottom mechanism, single or double case....1259
Jaws, with tang ends....1360
Lug, one-inch pipe....1017
Masts, Signal:
Adapter base for ground mast bottom mechanism....1387
Details and assembly....1035
Signals:
Semaphore bearings, mechanical....1082
Details and assembly for....1194
Signal, two-way single lamp:
Semaphore spectacle design "C" for....1235
Crank bearings and clamps for....1355
Double spectacle bearings and lamp bracket for.1356
Ladder, details and assembly for....1357
Stands:
Crank, two-way separate pin horizontal....1393
Low target....1399
Switch:
Adjustment, details....1390
Adjustment, non-insulated....1391
Adjustment, insulated....1392

It was recommended that this list of specifications and standards be published in the manual, as supplementary to list heretofore inserted, for information of the members.

(5) Requisites of Switch Indicators

The text on this subject, now in the Manual of 1915, relates to use of switch indicators on roads of two or more tracks. In reconsideration of this subject, it seemed desirable to revise the requisites so as to apply to switch indicators and signals on single track as well as switch indicators on roads of two or more tracks. In undertaking such revision, the committe concluded that it would be better to make a simple statement of the uses of switch indicators than to cast this statement in the form of an application of the subject in the standard code of block signal rules—the more so that this code has recently been revised.

The revised statement and requisites are given below. For convenience of comparison, each section is followed by the text of the superseded section or an explanation of the smaller changes.

Purposes

1. Switch indicators are recognized as an adjunct of the automatic block system. They may be arranged to indicate one or more of the following:

1-a. Whether or not a train is approaching.

1-b. Whether or not that portion of the block between the switch and the next Home Block Signal in advance is clear.

1-c. Whether or not the next Home Block Signal in the direction of approaching trains is at stop.

Superseded.—In the Standard Code of the American Railway Association, switch indicators are placed among the adjuncts of the automatic block system: "(C) Indicators at main track switches." It is recommended that the purposes for which switch indicators may be used, and their location and control, be specified by amplification of adjunct (C) and the addition of requisites of installation, as follows:

(C) Indicators at main track switches to indicate, on roads of two or more tracks, one or more of the following:

(a), (b) and (c) unchanged.

2. In a system equipped with switch indicators, indicators are unnecessary, and may therefore be omitted, at certain switches where signals are so located and controlled that the indications which would be given by the switch indicators can be obtained from the aspects of the signals.

2. New.

Requisites of Installation

1. Switch indicators located preferably:

1. Switch indicators, if practicable, located:

1-a. At main track switches connecting with tracks on which trains may clear main track and in which either there are no derails or diverging switches, or the derails or diverging switches are connected with the main-track switches.

a. No change.

1-b. At independently operated derails or diverging switches in tracks on which trains may clear main tracks.

b. No change.

1-c. At points from which switches of cross-overs between main tracks are operated, or locked, where both switches are operated or locked from the same point.

c. The words, "or locked," inserted in two places.

1-d. At independently operated switches of cross-overs between main tracks, the indicator at the switch in one track operated in connection with the other track.

d. No change.

2. A switch indicator for each direction where indications relating to traffic in both directions on the same track are to be given.

2. New.

3. Switch indicators that cannot be identified by their locations, marked with the designations of the tracks or the directions of traffic in connection with which they are operated.

3. Formerly 2. The words "or the direction of traffic" inserted.

4-a. The connections of switch indicators used to indicate whether or not a train is approaching, so arranged that an indicator will indicate the approach of a train that has reached a point at least such a distance in the rear of the second block signal in the direction of approaching trains, that if the switch is thrown at the moment when a train reaches that point, the Caution-signal will be displayed in time to be observed by the engineman, and will continue so to indicate until the train passes the Home Block Signal in the rear of the switch or, approximately, the clearance point of the switch when the switch is more than ..... feet in advance of the Home Block Signal. The distance of the point at which the approach of a train is first indicated will be determined in each case by the grade, speed of trains, view of the signal or other local conditions.

4-a. Formerly 3. No change.

4-b. Equivalent control of signals certain aspects of which serve, in lieu of switch indicators, to indicate whether or not a train is approaching.

4-b. New.

The committee recommended that these requisites for switch indicators be adopted and published in the Manual.

Work on Other Assignments

(6) The committee has under consideration a report of a sub-committee on overlaps in automatic signaling, and therefore reports progress.

(7) The committee has discussed and referred back a report of a sub-committee on giving signal indications other than by semaphore, and therefore reports progress.

(8) A sub-committee working on signals and signs is making headway.

(9) The committee presented an "Exposition of the Three Schemes of Signaling." In doing this particular attention was called to the fact that this report does not refer to the American Railway Association Code adopted November 17, 1915. An abstract of this exposition as presented to the Railway Signal Association was published in the Daily *Railway Age Gazette* March 21, 1916.

(10) A sub-committee has made a report on automatic train control, which has been referred back. The committee, therefore, reported progress.

(11) A sub-committee has in hand the matter of the merits in various locations of A. C. and D. C. automatic signaling, but has not yet presented a report.

(12) The committee cannot report any progress on the subject of a take-siding indicator.

Recommendations for Next Year's Work

The committee considers that it has completed the work on Subject 2, Economics of Labor in Signal Maintenance; Subject 5, Requisites for Switch Indicators, and Subject 9, Analyze Signal Schemes, and recommends that these subjects be closed. It further recommends that the following subjects be assigned:

1. Make critical examination of the subject-matter in the manual, and submit definite recommendations for changes.

2. Report on the problem of signaling single-track roads with reference to the effect of signaling and proper location of passing sidings on the capacity of the line.

3. Report on specifications adopted by the Railway Signal Association, which, in the judgment of the committee, warrant consideration, conferring with Committee on Track on any appliances affecting track.

4. Report on the desirability of having an overlap in automatic signaling; if so, is it best to have two stop indications between trains or two caution indications instead, or the latter in special cases only, such as down-grade tracks?

5. Report on the various methods of giving signal indications other than by means of the semaphore (this includes the light signal for day and night indications).

6. Report on the feasibility of separating into distinct types of their own (1) the signals for train operation, and (2) the marker or signs which indicate the location or position, or both, of information signs and switch signals for conveying information to trainmen. (1) The semaphore is now almost universally used for governing train operation; therefore (2) Design suitable day and night (if necessary) markers or signs for switch signals, derail switches, stop posts, slow posts, resume-speed posts, water station and track-pan markers, highway crossing signals, etc., conferring with Committee on Signs, Fences and Crossings.

7. Report on requisites of signal locations for interlocking and block signals.

8. Report on automatic train control.

9. Report on the comparative merits in various locations of alternating current and direct current for operation of automatic signals.

10. Report of applications of aspect for instructions to trains to take siding at a non-interlocked switch.

Committee: J. A. Peabody (C. & N. W.), chairman; W. J. Eck (Southern), vice-chairman; Azel Ames (Kerite I. W. & C.), C. C. Anthony (P. R. R.), H. S. Balliet (G. C. T.), A. M. Burt (No. Pac.), C. A. Christofferson (No. Pac.), C. E. Denney (N. Y. C. & St. L.), F. L. Dodgson (G. R. S. Co.), C. A. Dunham (G. N.), W. H. Elliott (N. Y. C.), G. E. Ellis (I. C. C.), John V. Hanna (K. C. Term.), J. G. M. Leisenring (I. T. S.), H. K. Lowry (C. R. I. & P.), J. C. Mock (M. C.), F. P. Patenall (B. & O.), A. H. Rudd (P. R. R.), Mott Sawyer (C. M. & St. P.), W. B. Scott (So. Pac.), A. G. Shaver (Cons. Engr.), T. S. Stevens (A. T. & S. F.), W. M. Vandersluis (I. C.).

Discussion

J. A. Peabody (Chairman): The first subject on which we are reporting is No. 2, "Continue the Study of Economics of Labor in Signal Maintenance." The committee submitted a preliminary report in 1914, and in 1915 a report which it requested should be accepted as information. The committee considers that these reports cover the subject and recommends that the subject be considered closed.

The President: If there is no objection this subject will be considered closed, as recommended by the committee.

Mr. Peabody: The next subject on which we report is No. 3, "Report on the Problem of Signaling Single Track Roads with Reference to the Effect of Signaling and Proper Location of Passing Sidings on the Capacity of the Line," and we request that what we have presented on this subject be accepted as a progress report.

The President: If there is no objection this will be accepted as a progress report.

Mr. Peabody: The fourth subject assigned to the committee is one on which we next report, namely, "Report on Specifications adopted by the Railway Signal Association, which, in the judgment of the committee, warrant consideration, conferring with Committee on Track on any appliances affecting track."

In reporting on this subject we are presenting a list of the matters acted on by the Railway Signal Association at its convention in 1916 and adopted by letter ballot this year. This is in conformity with our former practice in presenting this matter.

As to the last part of this subject, that is, with relation to conferring with the Committee on Track, the Committee on Track called on us for representation at one of their meetings. We were quite well represented, and, I think, gave them some information that is of value.

Your committee recommends that this list of the Railway Signal Association specifications and standards be published in the manual as supplemental to the list heretofore inserted for the information of the members of the association.

Mr. Peabody: I move that this matter be accepted by the association and printed in the manual. (Motion carried.)

Mr. Peabody: The next subject on which we report is No. 5, "Report on Requisites for Switch Indicators, including method of conveying information as to the condition of the block to the conductor and engineman." The committee recommends that these requisites for switch indicators be adopted and published in the manual. I move that this action be taken.

The President: Is there any discussion?

Mr. Safford: Before acting on that finally, I would like to ask the committee if there has been any change whatever from any principle enunciated in the American Railway Association code before we adopt this for printing in the manual?

Mr. Peabody: This is an amplification of the code. There is no change in principle.

(Mr. Peabody's motion was then put to vote and carried.)

Mr. Peabody: The next subject we deal with is No. 9, "Analyze the Signal Schemes which have been presented to the Association." I wish to give entire credit to Mr. C. C. Anthony, former chairman of this committe, for this report. The entire work was his, and his only. Your committee recommends that this part of our report may be received as information.

The President: Unless there is objection, it will be so received.

(The committee was discharged, with thanks.)

Report on Signs, Fences and Crossings

W. F. Strouse, Chairman

LAST year the committee submitted a considerable amount of information relating to track construction and flange ways at paved street crossings and in paved streets, together with a plan for a plank crossing similar to that adopted by the railroads and city authorities of Kansas City and later adopted by the Chicago, Rock Island & Pacific. This plan failed of adoption by the convention because it was believed it could not be universally used. While the committee realized this objection when the plan was submitted, it believed that this design was far superior to the original plank crossing extensively used.

Desiring further information regarding present practice, inquiries were addressed to 116 steam roads and 69 electric railroads asking for data concerning their standards. A total of 71 replies were received from the steam roads and 33 from the electric lines which were tabulated to show the size of the flange way provided, the number of roads using the flange way, the weight of rail and whether track was straight or curved.

Signs

There seems to be a growing feeling that railroads generally have too many signs along their roadways, and that many of those necessary are not always ornamental. The committee feels that the number should be reduced to only such signs which experience indicates are necessary for the safe handling of trains, and those found essential should contain among other features those of clearness of expression and durability. The use of metal signs, consisting of an old boiler tube post set in concrete with an iron or steel plate of proper size riveted to it is growing in popularity each year.

With a view to reducing the maintenance costs, various devices have been tried, such as concrete with depressed letters, and punched-out metal signs where letters and figures are punched or cut out, allowing daylight to take the place of paint. In view of the fact that in many localities the train movements are nearly as frequent at night as in the daytime, it would seem that comparatively few signs are really of much value, but they should be distinctive.

In the painting of signs, which forms a large part of the maintenance cost, the lettering introduces quite an item of expense. This part of the work requires an experienced painter, and if the signs are kept in proper condition, requires frequent repainting. If this class of work could be eliminated, the general painting could be done by the regular section gangs at a big reduction in the cost of maintenance.

To eliminate this expense it has been suggested that the contour of signs for the guidance of the train and engine men indicate their purpose, without lettering. On some roads this practice has been adopted to a limited extent, and it is believed that with proper consideration a set of signs could be designed which would cover the greater number of signs needed. The same style of post could in all probability be used with the different signs.

Wood signs require repainting at stated intervals and renewal at intervals of about eight or ten years. In the case of metal signs the cost of repainting need only be considered, as with proper attention they are practically indestructible when protected by a concrete base.

The nearest approach to eliminating the cost of lettering on signs is the signs in use on the Canadian Pacific. The blades of the signs consist of iron plates of various sizes with the letters and figures punched out, allowing daylight to take the place of paint. Some of these signs are placed on the various roadway structures, while those

not designating structures are attached to boiler tube posts, set in the ground. It is the opinion of the committee that these posts should be set in a concrete base to protect the boiler tube from rusting away.

Concrete Fence Posts

This year the committee, through one of its members, made an examination of a fence in Kansas, in which the posts were concrete of the staple type. The fence was built about four years ago, the woven wire being attached to the posts by staples driven into a composition in the center of the post. The fence is located on the top of a cut and along a portion of the distance is on a curve. The pull of the fencing against the posts has not disturbed the alinement and the general appearance of the fence after the lapse of four years is all that could be expected. The wire at places indicated that people had climbed over it and that there had been considerable pressure exerted against it by stock in the adjacent field. With all this the staples seemed to be as secure as the day they were driven. Apparently the conditions were about as severe as would be found ordinarily. Of the various devices of attaching wire fencing to the concrete posts this seems the most simple, and if it will prove durable in the long run will certainly commend the post to the public.

The chief engineer of the Waterloo, Cedar Falls & Northern Railway, reported on experiments with concrete posts: "During 1913 and 1914 this road constructed 60.6 miles of fence using concrete posts. The fencing consisted of all No. 9, 26-in. woven wire and three strands of barbed wire. The end and corner posts were 8 ft. long and 6 in. by 6 in. square at the base, tapering to 5 in. by 5 in. at the top. Intermediate or line posts made in 1913 were 4 in. by 4 in. at the base and 3 in. by 3 in. at the top, about 80 per cent being 6½ ft. long and 20 per cent 7 ft. long, reinforced with four 3/16-in. crimped wires and made in wooden molds. The line posts made in 1914 were 4 in. by 5 in. at the base, tapering to 3 in. by 3 in. at the top, were all 7 ft. long, were reinforced with four ¼-in. round rods, and were made in shaking steel forms. All posts were made from pit run gravel, the mixture being one part cement to three and one-half parts of gravel. About 10,000 line posts of the former type were used and about 5,300 of the latter type. The 10,000 posts made the first year were provided with galvanized loops projecting from the posts, the other ends of the wires forming these loops being fastened to the reinforcing. There are 14 of these loops on each post, forming seven pairs, so spaced that there was a pair for each barbed wire and four pairs properly spaced for the woven wire. The loops in each pair were about a half-inch apart, the idea being to put the barbed wire or the longitudinal wires of the fencing between the two loops and fasten by means of a tie wire passing through the loops and over the longitudinal wires. It has proven absolutely satisfactory, far better than the use of tie wires, which we adopted for the posts made the second year. With a smooth, tapering post no amount of care in tving will prevent stock from raising the fence wires.

"We have recently made a complete inspection of all the concrete posts on this sixty miles of fence and have found that of the 4,528 line posts made and placed in 1913, 71, or 1.57 per cent, are broken; of the 5,500 line posts made in 1913 and placed in 1914, 99, or 1.80 per cent, are broken; of the 5,300 line posts made and placed in 1914, 31, or 0.59 per cent, are broken. Nearly all these breakages occurred at the ground line and were apparently caused by crowding of stock. There is no apparent deterioration of the concrete in any of the posts.

"When it is considered that probably 3 per cent per year of these posts would have been destroyed by fire had wood posts been used, or over 900 posts in the two or three years these concrete posts have been in use, the average loss of only about 6/10 of 1 per cent per year, or 200 posts in all, does not seem to be excessive. The advantages of using the heavier reinforcing metal and jogging molds is very apparent, the percentage of breakage in this type of post being only about one-third as great as with the posts made in wood molds with 3/16-in. crimped wire reinforcing, although the size of the posts was only slightly increased.

"Our books show an average cost of $300 per mile of fence with concrete posts as against $380 per mile of fence with steel posts. It should be noted, however, that the steel fence was better built, more care being taken with curves, with stretching of wires and with anchoring to make it hog tight, etc.; it should be further noted that the manufacturers of the concrete posts who also contracted for all labor of setting posts, stretching wire, etc., lost a considerable sum of money on the work in spite of the fact that we made them allowances in excess of the contract price. In 1915, before deciding to use steel posts on the forty-odd miles of fence then about to be built, we took bids on concrete posts from the same people and others, and the prices then quoted would have made the fence cost over $400 per mile. The prices noted above include posts, woven and barbed wire, farm gates and all material and labor, except the material in sectional steel cattle guards."

Steel Fence Posts

In 1902 the Vandalia installed a number of steel posts on its Vincennes division. These posts are reported to be in good condition after over 14 years' service. The original wire fence rusted out and was replaced by new in 1912. The posts are more or less discolored by rust stains from the old wire fence, but when this is removed, the galvanizing is still intact. The steel posts are so highly thought of by the Vandalia officers that they have just recently fenced the new line from Indianapolis to Frankfort with steel posts and woven wire fencing.

Two years ago the committee made a report on two pieces of test fence built by the Baltimore & Ohio on its Philadelphia division, in May, 1913, in which a comparison was made between the cost of wood and steel posts, the cost of setting wood and steel posts and the cost of attaching the woven wire to them. This fence was recently examined and the galvanizing on the posts appears to be intact, no evidence of corrosion being found except on a few of the tongues provided for supporting the wire, where the galvanizing was damaged when the fence was erected. All galvanizing, however, has disappeared from the woven-wire fencing and some rust discolorations were found on the posts. When these were removed, the galvanizing seemed to be in first-class condition.

The Pennsylvania Railroad erected about three miles of wire fence on its line between Philadelphia and Baltimore in 1913, in which galvanized steel posts were used. A report just received from the above company is to the effect that no trouble has been experienced in maintaining this fence nor has it proven expensive from a maintenance standpoint, no attention having been given it since its erection. The chief value in this style of post as seen by the Pennsylvania is the ease with which it can be set, requiring very little labor to drive the post into the ground. The principal difficulty in setting steel posts probably arises when attempting to set them in stony ground, the tops of a number of the posts in the above-mentioned fences having been more or less badly battered and bent in the process of driving the same.

The most complete information on the subject of steel fence posts which the committee has been so far able to

obtain is a report by the chief engineer of the Waterloo, Cedar Falls & Northern:

"In the summer of 1911, this company built 12 miles of right-of-way fence. This fence consisted of No. 16 gage galvanized steel line posts 6½ ft. long, and No. 12 gage galvanized steel end and corner posts 7½ ft. long, of the tubular type. The line posts were driven and were spaced 20 ft. apart on tangents and 16½ ft. apart on curves. The end and corner posts were set in concrete with brace rods terminating in concrete thrust blocks. The fencing consisted of woven wire 26 in. high with two barbed wires above, spaced 10 and 22 in., respectively, above the woven wire, the bottom of which cleared the ground about 3 in., thus making a fence about 51 in. high.

"Owing to inexperience the gage of metal in end and corner posts was too light and these posts themselves were improperly designed. Another mistake was in using only two barbed wires with the 26-in. woven wire, at least three, and preferably four wires, in my opinion, being necessary for a good fence. The fence as constructed also lacked 3 or 4 in. of the height required by the Iowa laws, namely, 54 in. Another source of trouble is the leaning over of the line posts on curves, especially on curves of 2 deg. or sharper in ground that is damp or marshy.

"In spite, however, of all these mistakes in design of posts and methods of construction, the fence has proven generally satisfactory, and is in good condition to-day without having cost much for upkeep. A careful inspection of the posts fails to reveal any signs of corrosion, and we see no reason as yet to suppose that we will not obtain a long life.

"In 1915 our company built about 40 miles of steel post fence, using the same type of posts as those used in 1911. This fence is of too recent construction to give any valuable information as to its probable life, and is mentioned here because some features of its construction were perhaps unusual.

"The line posts used were No. 16 gage, about 25 per cent being 7 ft. long, for use in soft ground and 75 per cent being 6½ ft. long. The end and corner posts were heavier and better designed than those used previously, being No. 10 gage, 8 ft. long, and, being more truly cylindrical, offer more resistance to the slipping of the brace rod collar. The fencing consists of 26-in. all No. 9 special galvanized woven wire and three strands of barbed wire. Corner and end posts were set in concrete, the hole being about 18 in. in diameter, and the ends of the brace rods for these posts terminated in a 14-in. cube of concrete. All line posts were driven, and after driving were straightened up and tamped. An unusual feature of this fence is that on curves of 1 deg. or heavier it is run along the chords and tangents of the circle instead of on the circle itself, the object being to prevent the stretch of fence from pulling the line posts out of plumb. In order to prevent any dispute with adjoining owners, and as the width of our right-of-way was ample, we laid out these chords and tangents entirely on our own land, building it along chords on the outside of the curve and along tangents on the inside of the curve, the greatest deviation of the fence from the true property line being about 12 in. On a one-degree curve this practice would bring an angle in the fence about every 214 ft. and on a two-degree curve these angles would be about 151 ft. apart. At these angle points, a regular end post set in concrete was used on the outside of the curve. On the inside of the curve, since it would not be practicable to use a brace rod projecting onto the adjoining land, a regular line post was used, set in a small amount of concrete and secured by wires attached to a 5-in. guy anchor. The additional cost on the outside of curves due to the extra end posts is, of course, considerable, but this is partly offset by the spacing of the line posts farther apart than would otherwise be possible. The construction on the inside of curves does not add to the expense since the cost of concrete, guy anchor and wire is, we think, entirely offset by the saving in posts.

"One of the heaviest items of expense in constructing a fence with steel posts of this type is the concreting of the end and corner posts. Some makers of steel fence posts have placed on the market various end posts that do not require concrete. We have tried a few end and line posts constructed out of angle iron, and while they have been in service only a couple of years, they seem to be standing up well.

"The practice of spacing line posts 20 ft. apart is not in accordance with the standards of the Association. However, the saving amounts to about $25 per mile, and we are satisfied that no closer spacing is necessary if the fence is properly stretched. One of the greatest troubles we have experienced with combination woven and barbed wire is the sagging of the woven wire by stock reaching their heads between the woven wire and the barbed wire above, which trouble occurs with either 16½-ft. or 20-ft. spacing of posts. This can be overcome by wiring the barbed wires to the woven wire half way between the posts or by the use of one of the spiral wire stays now sold for that purpose."

Reduction of the Number of Roadway Signs

In view of the difficulty of reading signs at any considerable distance, it is believed that all roadway signs for the guidance of all train and engine crews should be free of lettering of any sort, making the contour of the sign indicative of its purpose. In following out this suggestion it would probably increase the variety of signs already in use, as it would not be practicable to use two signs of the same general dimensions and shape but conveying different information. Nor is it desirable to depend entirely on the lettering for identification, especially on prairie roads where landmarks are few and it is no uncommon thing for engineers to lose their sense of locality during severe storms at night or in blizzards.

Considerable attention has been given the matter of concrete signs, but so far the committee has not learned of any very satisfactory or economical results except in the case of the smaller signs, such as mile posts, property posts, etc. The Baltimore & Ohio has during the past year installed a number of concrete whistle posts, made in accordance with a standard plan adopted a year or more ago. The results so far have not been entirely satisfactory, and considerable loss was sustained by the manufacturers on account of breakage. The stem as designed is light in section and does not seem to have sufficient strength to stand handling. If this objection cannot be overcome with economy there does not seem to be any advantage in changing from the metal post heretofore used.

It is the committee's belief that a set of signs can be designed in which the post, which can be made of iron pipe cast into a concrete base, can be made standard for the greater number of roadway signs. Any style of head or blade, made of any suitable material, can be bolted to the post, thus doing way with the necessity of having a great number of different styles of posts as at present.

Abstracts of Laws Relating to Fences and Stock Guards

The committee presented abstracts of the requirements of the laws of the different states and of Canada relat-

ing to the installation of right-of-way fences and of stock guards.

A Comprehensive Study of Crossings

One of the subjects assigned to the committee involved a comprehensive study of grade crossings and the methods of protecting them. As the American Railway Association is now investigating this subject the committee considered it advisable to defer action until next year. It has gathered considerable information on the general subject of grade crossing elimination and presented an abstract of a paper by J. Bayles Reilly of the Boston Society of Civil Engineers and published in the journal of that society for April, 1915, which paper gave considerable information concerning the apportionment of the cost between the railways, the public service commissions and the public and the manner of procedure in separating these grades.

Recommendations for Next Year's Work

1. A careful investigation of all styles of metal posts that have been in use long enough to warrant any conclusions as to their durability.
2. A study of the various types of end or strain posts used with steel fence posts, with a view to recommending a type which would be a satisfactory substitute for posts set in concrete, the cost of which is high in those now in use.
3. A further study of the subject of concrete fence posts now in use by various railroads.
4. Make an investigation as to the best method of bracing concrete end or strain posts.
5. Submit a revised analysis of the comparative annual cost of fences, using wood, metal and concrete posts, with a view to bringing this subject, considered by the committee in 1912, up to date.

Committee: W. F. Strouse (B. & O.), chairman; Arthur Crumpton (G. T.), vice-chairman; F. D. Batchellor (C. H. & D.), C. G. Bryan (I. C.), G. F. Black (Me. C.), A. Copland (C. & O.), R. C. Gowdy (F. W. & D. C.), Maro Johnson (I. C.), L. C. Lawton (A. T. & S. F.), S. L. McClanahan (C. R. I. & P.), L. A. Mitchell (Un. Trac. Co.), T. E. Rust (W. C. F. & N.), C. H. Splitstone (Erie), A. Swartz (T. & W.).

Discussion

The reports on subjects 1, 2, 3 and 4 were accepted as information.

W. F. Strouse (chairman): The subject assigned as No. 5 is, "Report on Legal Requirements relative to the provision of fences for right-of-way and stock-guards."

H. R. Safford (G. T.): In connection with this part of the committee's report, I presume that this subject will probably be referred back and will be made the ground of some further study, and I would like to suggest to the committee that they take the data relating to legal requirements and attempt to put it in tabular form, preserving all the essentials. That manner will be found the best for making use of the different requirements of states and the national authorities.

In this connection I think it is not out of place to say that I believe that we are approaching a time when we will want to suggest to the various states that a uniform design of fence be adopted. I believe that this association can probably secure a uniform fence law if the members of the association will back such a movement. With that in view, this committee could be of considerable aid in the attempts which may be made to carry out that kind of a program if they would tabulate this information; after which I believe that the railways represented in this association ought to make some concerted effort to try to have adopted a uniform type of fence. I think it can be done, and I believe the railway commissions, as a rule, will not oppose a recommendation in connection with this matter, which recommendation has the general approval of this association.

John G. Sullivan (Can. Pac.): There is one point I would like to refer to, and that is to give the dates of these laws. Such laws are changed, from time to time, and it would be well if we could cover that point in our compilation so that anyone referring to these laws would know the date when they were put into effect.

Mr. Strouse: The dates are given, I believe, in almost every case. There may, however, be some changes to be made.

Mr. Sullivan: It might be well to insert a note that the laws were effective in 1916, and if the date is given they will not be relied upon too implicitly by a man who may take up the manual 10 years from now, but he will ascertain whether there have been revisions to these laws.

Mr. Strouse: That might be well.

The President: The committee accepts the suggestion made by Mr. Safford, and unless there is objection this portion of the report will be accepted as information and published in the proceedings.

Mr. Strouse: Subject No. 6, which was assigned to the committee, is, "Report on classification of fences into 'types.'"

The committee spent a considerable amount of time a year or two ago on the subject of fences and specifications and different classes of fences, etc., were approved at that time and placed in the manual, so that the committee did not consider it advisable to take up this subject this year, in view of the fact that there were so many other things that had to be eliminated.

Subject No. 7, which was assigned to the committee, is, "Make a comprehensive study of crossings."

This appeared to be such a big subject that the committee did not feel it should be taken up this year. It has, however, submitted a paper prepared by J. Bayles Reilly, which gives his personal experience in connection with the elimination of grade crossings in Massachusetts.

In addition to this paper a very valuable and complete report was submitted to this association two years ago, I believe, by C. E. Smith, in which a great deal of information bearing on the subject of elimination of grade crossings is given.

The information included in this report, together with other information that has already been published, I feel could be made the basis of a report on the general subject of crossings which the committee should follow up next year.

C. C. Williams (University of Kansas): I wish, as a member of another committee, to express my high appreciation of the work of this committee on the subject of grade crossings. In investigating the great subject of conservation of resources, financial and otherwise, of the railways, our Committee on the Conservation of Resources found that the question of grade crossings was becoming an extremely important one. When the automobiles become so presumptuous that they will make a determined practice of running into railway trains, I think it is high time that the railway companies took action to protect themselves.

The California Railway Commission and other commissions, perhaps, have been making an extended study of this subject of automobiles failing to notice the railway crossings, and the owners and operators of these

automobiles thereby subjecting themselves to injury and death and destruction of property.

E. R. Lewis (D. S. S. & A.): I think possibly we should not commit ourselves to the phrase: "If this class of work could be be eliminated, the general painting could be done by the regular section gangs at a big reduction in cost."

I suggest that on page 423 of the manual will be found 131 rules adopted by this association, all of which apply to work to be done by the regular section gang. By the time the regular section gangs do what is laid down there, there is not going to be a great deal of daylight left to them for the painting of signs, and after that they have to take care of the track.

I do not want to see this association committed to any such proposition, unless they really believe they want to be. Unfortunately, this is in line with the ever-recurring idea of railroad officers that the section man can do any kind and all kinds of work because no other labor is quite so cheap in first cost nor quite so handy in being Johnny-on-the-spot.

The place of the section man is on the track all the time. Every minute spent off the track is lost. To take the section hands to do work of this kind makes a most expensive work.

I make a motion that this phrase be omitted, because I do not think it is vital to this report, and I do not think it expresses what we desire to convey.

The President: Acting in accordance with Mr. Lewis' suggestion, the committee will eliminate that sentence from the report.

Mr. Strouse: The committee desires to call attention to the recommendation for next year's work. It failed, however, to mention that the subject of flangeways had not been disposed of. That subject, I think, should be given further consideration with the other subjects next year.

(The committee was excused, with thanks.)

Report of the Committee on Water Service

A NUMBER of changes in the Manual were recommended to render the language clearer and to remove certain ambiguities.

Methods for Rejuvenating Driven Wells

While the subject as assigned mentions driven wells only, it is the opinion of the committee that the discussion should include such drilled wells as may be constructed in unconsolidated materials and requiring the use of a strainer, as this type of well is in more general use for railway water service than even the driven well. The report has been prepared accordingly.

A. F. Dorley, Chairman

The gradual lowering of the ground water level and the proximity of other wells may be sometimes mistaken for a defect in the well, and careful comparative tests are necessary where the actual head and delivery is in doubt. The ground water level has lowered decidedly and continues to decline in certain sections of the country. While this decline has not been confined to any particular section, it has been marked in Indiana, southern Michigan, the Great Plains and southern California. This loss of head may be accounted for in part through the reckless waste of ground waters from flowing wells.

When making repairs to wells it is necessary to consider the construction of the well and the possible effect the construction may have on the method to be followed in making repairs. Faulty construction is in many instances responsible for a well failing to come up to expectations. Some of the principal faults of construction likely to cause a well failure or seriously interfere with the production of a well may be enumerated as follows:

The strainer may be only partially exposed to the water bearing sand or it may be set either too high or too low. If the water bearing stratum is quite thick, the sand composing the top of the vein will be found much finer than the bottom, consequently it is always desirable to set the strainer in the bottom of the stratum. At the same time the strainer should not be set beyond the bottom of the stratum for obvious reasons.

Another fault in construction may be due to the strainer not being properly swaged in place. This will result in sand entering the well between the packer and casing, or if the packer is not firmly swaged out against the casing the screen may work up in the casing decreasing the exposure. The screen is sometimes damaged in setting, causing the well to gradually fill with sand in the same manner as though the strainer had become worn with use. Where mud-laden fluid is used in drilling the well, it is essential that all mud be thoroughly washed from the sand to avoid the possibility of the mud packing around the screen and shutting out the water.

The removal of a strainer from the well for the purpose of renewing or making repairs is an operation that sometimes meets with considerable difficulty, especially if it is not possible to pull it by the bail. When the bail breaks in pulling, as is often the case, it is then necessary to make the pull with a fishing tool or pulling device, or by lowering a pipe line in the strainer and filling in between the pipe line and strainer with sand or gravel. The pulling line should have a fitting of some kind such as an increaser or bushing and coupling on the lower end of sufficient size to nearly fill the strainer, the sand or gravel is then poured in the well and the pipe jacked out. This method is very effective and invariably permits of pulling the strainer, no matter how tightly it may be lodged in the sand. Extreme care must be exercised to prevent the sand or gravel from extending above the top of strainer, as it may lodge between the strainer and casing, necessitating pulling both strainer and casing or ruining the well.

A complete discussion of the many causes of diminished yield and the methods to be followed in rejuvenating wells would require too much time and space, consequently the discussion will be confined to the two principal causes of well failures, i. e., wells throwing sand, and yield diminishing on account of the incrusting of strainer.

Wells may yield sand for various reasons, including: A defective or worn strainer; defective casing, or a defective packer.

The first necessitates the removal of the strainer. If the defects consist of small breaks in the strainer they are soldered and the strainer replaced in the well. If

the breaks are too large to be repaired or the screen is worn throughout, it is, of course, necessary to insert a new strainer. A defective packer is usually due to improper swaging or to its being damaged by the lowering of tools or dropping material in the well. It can usually be repaired by reswaging, or if the reswaging fails to accomplish results a special seal and packer may be inserted.

A defective casing may be repaired in the same manner as the packer by inserting an emergency seal and packer and sealing off the break. The chief difficulty is in locating the defect, but if the break cannot be located definitely a smaller casing may be inserted inside the well casing, making a seal just above the strainer. The objection to this method is that it reduces the size of the well. If a drop line is used on the pump, however, this difficulty may be overcome by setting a plain working barrel in the inner casing and using it as a drop line.

The principal cause of wells diminishing in yield of water is through the incrusting or clogging of the strainer. If the clogging consists merely of loose material not cemented, it may be removed by "open flushing," "churning," "back pressure" or "tool flushing."

Open flushing consists of pumping water into the well through a wash line, extending to the bottom. This wash line also washes the sand out of the strainer and, if effective, the well will take the water freely after washing thoroughly.

Churning consists of forcing the water back and forth through the strainer and may be accomplished by removing the foot valve and running the pump rapidly, as the action of the plunger with the foot valve removed alternately creates a pressure inside and outside of the strainer and is effective in relieving the strainer of loose sand. Churning may be elaborated by removing the drop line and putting a large plunger in the well casing, working it back and forth with an engine; great care will have to be exercised with this method, if the strainer is old and weak, to avoid collapsing it.

Back pressure is applied to the well by making a connection to the casing and sealing the top of the well. The connection should be made with the pump in place so that the pressure may be applied and the well pumped alternately. Pressure should be applied for 10 or 15 min. periods. The water in the well should then be turbid, the pressure should then be relieved, the pump started and the well pumped until the water clears up, when the pressure should again be applied, this process being continued until the desired result has been obtained.

Tool flushing consists of inserting a tool on the end of a wash line for washing a small portion of the screen at a time. This tool is constructed of rubber and metal, and when placed in the well it may be expanded against the wall of the strainer, directing the water against any desired portion of the strainer instead of having the entire strainer receive the pressure as with open flushing or back pressure. The tool is gradually moved to the bottom of the strainer, thereby freeing the strainer of sand for its entire length. When the sand is badly cemented around the strainer it is necessary to remove the strainer for cleaning and insert a spring jetting reamer to break up the cemented sand. This reamer is so constructed that the pressure of the water forces out the cutting jaws beyond the casing. By revolving the reamer as it is lowered through the cemented sand it is broken up and forced out by the water. The tool flushing and reaming processes are used extensively and with great success by the city of Memphis, Tenn., the municipality having over fifty wells ranging in depth from 400 to 600 ft.

Badly incrusted strainers may be cleaned after their removal from a well by using a bath consisting of a solution of muriatic acid. Great care should be exercised in the use of acid to avoid damaging the strainer. The solution should not be stronger than one part of acid to ten parts of water. A still weaker solution may be prepared and the strainer allowed to remain in the bath for several hours. After cleaning, the strainer should be thoroughly washed in clear water to remove all trace of the acid. This method of cleaning is particularly effective with strainers of the Cook and Johnson type with very fine slots.

Explosives are used to some extent in water wells for the purpose of increasing the supply and there appears to be no good reason why, under favorable conditions, their use should not be as beneficial as in oil wells. If water is drawn from rock, breaking up or fissuring the rock will certainly increase the area from which delivery of water is made to the well. In a limestone region where the underground water, like the surface water, runs in more or less definite channels instead of percolating slowly as a broad and thick sheet, the shooting of a well will almost surely increase the number of contributory veins. In such a region the success of a well depends so largely on chance, the diameter of the hole being small and the water veins few, that shooting would seem to be beneficial to all wells and to determine absolutely the success of some. It would appear that the experiment should be more generally tried.

Shooting is sometimes recommended to break up cemented sand as well as to increase the supply of water in consolidated materials. Shooting a cased well, however, is liable to damage the casing, and unless the greatest care is exercised will do more harm than good. In shooting a cased well small charges of 60 per cent dynamite should be used, increasing the charge if necessary. The charge may range from ½ lb. up, depending on the work to be done. A large charge is usually placed in a tin tube or protected by a covering that will exclude water. Gelatin dynamite will not be affected by water. Small charges may be attached to a weight of some kind. An electric detonator is imbedded in the cartridge with the wires carefully sealed. The charge should be lowered into the well by a separate wire to the desired point and fired with an electric blasting outfit.

It is almost impossible to give any definite figures as to the cost of repairing wells, as the conditions vary to such a great extent. The following figures on the cost of repairs as compared with the cost of new wells are based on 10-in. wells 500 ft. in depth using No. 10 cut Cook strainers 50 ft. long. The wells are constructed in unconsolidated materials by the rotary method:

Cost of open flushing	$ 25 to $ 40
Cost of tool flushing	100
Taking out old strainer, repairing and replacing in well	300
Removing old strainer, cleaning well, placing new strainer	750 to 1,000
Cost of new well	2,500

There is no question but what the great majority of failing wells may be rejuvenated at an expense less than the cost of a new well, although the expense for repairs will depend largely on the method of construction. In drilling new wells it is wise to consider the necessity of repairs, and construct the well accordingly. For example, where a well is sunk in a formation that will cause excessive corrosion or incrusting of a strainer, the strainer should be of the inserted type rather than one which forms a part of the casing as the inserted strainer may be removed and repaired or a new strainer

placed without disturbing the casing. Where the casing has been set for some time, it is practically an impossibility to remove it and make another well in the same hole, as even when the casing may be pulled intact the cost of replacing is equivalent to sinking a new well.

One middle western railroad has over two hundred wells in unconsolidated materials, varying in depth from 100 to 1,100 ft. It is the practice on this road to use nothing but inserted strainers. In some wells the strainers are renewed annually. There are instances where eight or ten strainers have been applied to a single well.

Types of Well Strainers in Use

When a well is sunk into unconsolidated materials a screen or strainer must be used that will permit the water to enter and at the same time exclude sand in serious amounts from the well. These strainers are of various types, from the ordinary perforated pipe to the more elaborate slotted brass tube and wire-wound strainers. The best design of strainer for this purpose will depend largely on the class of material forming the water bearing stratum and to a certain extent on the character of the water.

Perhaps the best-known well strainer in general use consists of a single piece of seamless brass tubing perforated by slotted openings placed horizontal to the screen. These slots are of varying widths from No. 6 to No. 60 cut. The numbers of the slots are in thousandths of an inch, number 6 equaling 6/1000 in., etc. The slot opening is cut with a beveled edge from the inside, making the slot wider on the inside than on the outside. This reduces the friction to a minimum and also tends to reduce the clogging of strainer. The strainer is fitted with a bail at the bottom for pulling and setting and with a lead packer for sealing the top of the strainer where the strainer is inserted after the casing is placed. Strainers are also furnished with a plug and packer to be set after the strainer is placed in the well or with a back pressure valve for setting the strainer without jacking back the casing. An 8-in. strainer 10 ft. long has 9,000 openings.

Another strainer similar in appearance, although of entirely different construction is formed by winding an interlocking flat wire on a mandrel. The outside of the completed strainer presents a smooth surface with continuous openings the full diameter of the strainer, while the inside of the strainer presents a series of rectangular openings considerably wider than the outside slots. This permits the water to enter the strainer without undue friction and also serves to reduce the clogging of the strainer. This strainer is reinforced with longitudinal brass rods fastened at the top and bottom and soldered to the strainer well. The strainer is furnished with a bail in the bottom and lead packer.

There is little to choose between these two strainers. While the first, constructed of one piece, is more substantial and may be subjected to a harder pull when it is necessary to remove it from the well, the second has the advantage of greater capacity for the same length and size of strainer on account of the openings being continuous. This feature is particularly advantageous where the sand is very fine and the water bearing stratum is limited. The second strainer may be readily pulled by the bail where the sand is free, but where the sand grips the strainer tightly and necessitates using pulling tools other than a strainer hook the construction of the strainer makes it difficult to pull without completely destroying it.

The V wire strainer is formed by winding a V shaped wire around a perforated pipe, the narrow edge of the wire being next to the pipe, leaving a narrow opening on the outside and the wide opening on the inside. The outside of the strainer presents a smooth surface to the sand. This strainer has smaller perforations in the pipe core than many of the wire-wound strainers, which is claimed to give greater strength.

The ribbed core strainer is similar to the strainer just described except that a special pipe core is used with longitudinal ribs which hold the wire away from the pipe. A V-shaped wire is used and the ribs are notched to receive the wire and insure uniform spacing.

The inserted button strainer is formed by perforating a pipe of the desired size and inserting slotted brass buttons. A strainer of this type will undoubtedly stand rougher usage without damage than almost any other type of strainer. The strainer area is very limited, as there is but a small portion of the screening surface exposed to the sand.

Where the water bearing material is very coarse, such as a gravel formation, good results may be obtained by merely perforating the lower end of the casing or inserting a perforated pipe strainer through the casing. The perforated pipe strainer presents the advantages of being cheap and durable. It is also easily obtained, as the pipe may be perforated in the local shops. The principal objection to the general use of this type of strainer is that it is limited to use only in coarse gravely formation and that the perforations become corroded and fill up with rust. The latter objection has been overcome in some instances by bushing the holes with brass. In other instances the holes have been drilled and reamed and the pipe galvanized.

The perforated pipe strainers are used in many modified forms, some consisting of pipe slotted ¼ in. wide and 12 to 18 in. long. This type of strainer is particularly satisfactory where the water is lifted by air or centrifugal pumps, as these pumps will handle a certain quantity of sand without damage, always providing there is enough coarse sand and gravel to limit the quantity of fine sand pumped out so that cavities do not occur around the strainer large enough to cause caving of the roof.

Another type of slotted strainer is constructed by perforating a wrought-iron pipe and countersinking the holes, after which the pipe may be galvanized to resist corrosion. The pipe is then covered with a coarse galvanized screen which permits securing practically the entire screening surface. This screen is then covered with slotted copper or brass strips soldered to the screen. The strainer is then protected from damage by longitudinal steel strips. This type of construction may be varied by covering with copper or brass gauze instead of the slotted strips.

A popular type of strainer much used in artesian wells in the South, especially in Louisiana and Texas, consists of a pipe perforated with ½ or ⅝-in. holes and wound with No. 10 galvanized wire, then covered with ¼-in. mesh galvanized screen and finally with a brass gauze on the outside. Built-up strainers having a perforated pipe as a core, possess the advantage of great strength, but their construction makes them more susceptible to clogging and corrosion than the brass tube strainer and their general use is inadvisable except under favorable conditions.

In some instances wood pipe has been used as a core for screens to prevent corrosion, the pipe being perforated and wound with wire and gauze. Its use has not been general, and is still a matter of experiment.

A very durable and non-corrosive strainer has been constructed of cast-iron pipe covered with manila or cocoa fiber. This combination of cast-iron and fiber

certainly makes a very durable screen, as both are practically imperishable in water. The fiber strainer must be constantly submerged, as it decays very quickly out of water. This type of strainer has been used with apparent success on the Santa Fe in Kansas, Oklahoma, Texas and New Mexico.

A cement strainer is being manufactured with perforations about $\frac{1}{16}$ in. in width by 1½ in. long, the wall of the strainer being about 2 in. thick. This type of strainer has been used quite extensively in Kansas, though its use would appear to be limited to shallow wells in coarse sand.

Conclusions

It is impossible to specify a cerain type of strainer to meet all requirements. Each of the many strainers on the market today has been evolved to suit a certain condition and for the specified service will probably answer the purpose to better advantage than any other type. Ordinary waters do not have a marked corrosive effect on strainers, and any excessive trouble of this kind, except in the West and Southwest, is the exception rather than the rule.

Through Illinois, Kentucky, Tennessee, Mississippi and Louisiana many strainers are still in service after 15 to 20 years with little apparent deterioration. The chief trouble with strainers in this territory is due to incrustation and the wearing of the openings by the action of the water and fine sand.

In selecting a strainer the first essential is to determine the mesh or size of opening required. This may be determined by collecting samples of the materials comprising the water bearing stratum, using care that the samples represent a fair average of the various kinds of sand and gravel encountered. The strainer selected should permit the very fine grains to pass through and hold back the grains of medium size. The well should be pumped thoroughly until all the fine sand is removed before it is placed in service.

The service to be obtained from a certain type of strainer can be determined only by trying out the strainer apparently best suited to conditions, although a careful analysis of observations of other wells put down in the locality will be useful in determining the strainer to be used.

Generally where the water has a corrosive effect it is necessary to use a tubular brass strainer or one wound with heavy brass wire, as the gauze wound strainer does not offer much resistance to corrosion. The perforated pipe strainer cannot be used with success where the water bearing stratum does not consist of very coarse sand or gravel unless the well is gravel treated.

For general use an inserted strainer with lead seal is to be preferred on account of the possible necessity of removing the strainer for cleaning. A great objection to having the strainer attached to the casing is that it is subject to damage in setting, particularly if there is any rock or shale in the well. This type of strainer has one great advantage in that it lends itself for splendid use where it is desired to tap more than one water bearing stratum, as this strainer may be set at any point in the casing or at as many places as may be desired.

Methods for Complying With Federal Regulations in Regard to Purity of Drinking Water Supplied on Interstate Trains

The following report, prepared for the committee by R. C. Bardwell, assistant engineer in charge of water treatment on the Missouri Pacific, gives the present status of the efforts made by the railways to comply with the Federal regulations.

On January 25, 1913, the Federal Interstate Quarantine Regulations No. 6 were amended as follows:

"Article 3, General Regulations, is hereby amended by the addition of the following paragraph:

"Paragraph 15. Water provided by common carriers on cars, vessels or vehicles operated in interstate traffic for use of passengers shall be furnished under the following conditions:

"(a) Water shall be certified by the state or municipal health authority within whose jurisdiction it is obtained as incapable of conveying disease: *Provided*, That water in regard to the safety of which a reasonable doubt exists may be used if the same has been treated in such manner as to render it incapable of conveying disease, and the fact of such treatment is certified by aforesaid health officer.

"(b) Ice used for cooling such water shall be from a source the safety of which is certified by the state or municipal health authority within whose jurisdiction it is obtained, and before the ice is placed in the water it shall be first carefully washed with water of a known safety, and handled in such manner as to prevent its becoming contaminated by the organisms of infectious or contagious diseases: *Provided*, That the foregoing shall not apply to ice which does not come in contact with the water which is to be cooled.

"(c) Water containers shall be cleansed and thoroughly scalded with live steam at least once in each week that they are in operation."

At the same time a committee of 15 men, composed of the most prominent bacteriological, health and water experts in the country, was appointed to formulate standards for the purity of the water to be acceptable under this regulation. This committee, on October 21, 1914, reported recommendations for the limits of permissible bacteriological impurity after devoting more than a year to the discussion of the problem. These standards were adopted by the Treasury department, under whose jurisdiction public health matters are supervised, and they have since been in force.

During the first year and a half following the adoption of this amendment there was more or less confusion in regard to compliance. Certificates were demanded semi-annually, signed by the state or municipal health officer in his respective jurisdiction, stating that the water used was free from organism and materials liable to cause disease in man. In many cases it was possible to have the local health officers readily furnish the necessary certificates as neither the method nor the extent of examination required was stated, but with the adoption of the stated standards this has become more difficult. At the time the amendment was made, it can be stated that but very few municipal health officers had the necessary equipment to make the standard tests, and this is still largely the fact. This first also applies to many of the state public health boards under whose supervision the amendment operates. However, the fixing of the standards necessitated the special training and apparatus for a person competent to handle the delicate technic for the demarcation between the undoubtedly safe water and one which should be condemned, and most state boards are now equipped with laboratories to handle tests satisfactorily.

To date two general methods have developed for taking care of the situation.

First, reliance is placed altogether on the various state or municipal health boards to handle through their laboratories the examination of the waters and furnish the necessary semi-annual certificates in regard to their purity to the surgeon-general. In most cases the water for drinking purposes for use on passenger equipment is secured from municipal supplies, so that no additional labor on the part of these authorities is involved outside of signing the necessary semi-annual certificates as required by the Federal regulation, as progressive state boards keep in close touch with the condition of their municipal water supplies at all times and it is their object to see that a safe, wholesome water is supplied. There has been admirable co-operation between many of the states and the railroads in this respect, but in some cases the states have made extra charge for signing the certificates, presumably as a fee for making special examination, although this should not be necessary and the viewpoint is changing. At points outside of mu-

nicipal supplies the same treatment should be expected as is accorded any private concerns.

The other method in practice is to have a bacteriological laboratory established by the railroads under the supervision of a competent man trained in this bacteriological work. The semi-annual or more frequent tests are made by him or under his supervision and sworn to in respect to authenticity and accuracy. These analyses are then given to the local health officers where water is taken and if satisfactory he can sign the required certificate to be forwarded to the surgeon-general in full compliance with the regulation. This method has the disadvantage in some cases of arousing the antagonism of the state authorities and in a few instances has caused legislation to the effect that the official analyses must be made at the state laboratories. However, it has the advantage when run by competent men in full accordance with the standard methods, of being able to take care of all special cases outside of the drinking water supplied passengers, and is especially valuable in compliance with the amendment to Interstate Quarantine Regulation No. 8, in respect to the purity of drinking water supplied to all crews and employees.

Out of 18 answers to inquiries addressed to different railroads with a view to ascertaining which method was being used, 8 advised that regularly equipped bacteriological laboratories had been established for making original tests, investigations and check tests. The remaining 10 advised that they rely entirely upon the state and municipal laboratories.

On September 16, 1914, the following amendment was made to Interstate Quarantine Regulations No. 8:

"Article 3, General Regulations, is hereby amended by the addition of the following paragraph:

"Paragraph 17. Common carriers while engaging in interstate traffic shall not furnish to their crews or employees any polluted water for drinking purposes which may contain organisms or materials likely to cause a contagious or infectious disease, nor shall such carriers maintain or permit to be maintained upon their vessels or vehicles, or at or near their stations or other ordinary stopping places over which they have control, any tank, cistern, receptacle, hydrant or article with water which may contain such impurities, in such manner that water therefrom may be conveniently obtained by the crews and employees mentioned for drinking purposes, unless such common carriers maintain a notice upon said vessels or vehicles and at, near, or upon every said tank, cistern, receptacle, hydrant, pump, well, stream, brook, pool, ditch or other place or article, with water therein containing such impurities, forbidding the use of such water for drinking purposes by the crews or employees of the said common carriers or by the general public while engaging in interstate commerce."

This regulation is very far-reaching in statement, and if followed up with the standard tests for absolute safe drinking water as outlined in case of water supplied for passengers on cars, for every pump, hydrant, tank, well, etc., on the right-of-way, would put a tremendous burden upon the railroads. Consequently the provision in the last sentence for posting signs forbidding the use of such waters for drinking purposes whatever may be their condition is being taken advantage of in the majority of cases. Several of the railroads which have bacteriological equipment are undertaking to test and classify all sources of drinking water before posting same as forbidden.

Rules or Examination Questions for Care of Boilers in Pumping Stations

In addition a list of questions with their answers covering the care of boilers, and another on internal combustion engines; and the duties of a pumper or water station attendant were submitted, although in some respects they were incomplete.

The committee felt that there is need of similar lists of questions covering the operation of other types of pumping machinery, as, for instance, electric equipment. Work by the committee on these additional lists is under way, but sufficient time was not available to cover the entire subject in complete form for this convention. The committee suggested that this subject be reassigned for further study during the coming year.

Suggested Subjects for Next Year's Study and Report

Continue the study of methods for complying with Federal regulations in regard to purity of drinking water supplied to the public and employes on interstate trains.

Make final report on the design of impounding reservoirs, and the conditions under which they are economical.

Make final report on the relative merits of continuous and intermittent water softeners.

Make final report on rules or examination questions for the care of boilers in pumping stations.

Report on an organization for railway water service department.

Report on the definition of terms used in railway water service.

Report on suitable types of water meters for use in railway water service, the methods followed in testing and reading meters, and checking the consumption of city water.

Committee: A. F. Dorley (M. P.), chairman; J. L. Campbell (E. P. & S. W.), vice-chairman; J. T. Andrews (B. & O.), C. A. Ashbaugh (G. C. & S. F.), W. K. Barnard (Cons. Engr.), F. T. Beckett (C. R. I. & P.), M. C. Blanchard (A. T. & S. F.), C. Bucholtz (Erie), C. C. Cook (B. & O.), R. H. Gaines (K. C. S.), Otto Gersbach (I. H. B.), W. C. Harvey (C. G. W.), C. R. Knowles (I. C.), E. G. Lane (B. & O.), W. A. Parker (S. J. & G. I.), H. N. Rodenbaugh (Sou.), R. W. Willis (C. B. & Q.).

Discussion

A. F. Dorley (Chairman): I move that the revision of the manual as presented in this first portion of the report be adopted and used in the next edition of the manual.

C. E. Lindsay (N. Y. C.): In connection with article 7 (reading), "There are two general types of water softeners, the continuous and the intermittent, differing widely in their mechanical details," will the committee consent to the omission of the word "mechanical?" There are different chemical methods.

Mr. Dorley: They really do not differ in their chemical methods. Chemically, they accomplish the result in the same way, that is, chemically. The difference really consists in the method of adding chemicals to the water, methods of agitating the water, and methods of allowing sedimentation to take place, etc., but the primary difference is in the mechanical features of the plant.

A. C. Irwin (C. M. & St. P.): I understand the suggested revision refers to the method of applying the chemical to the water, and in my opinion the suggested revision does not bring that out clearly. It might better read—"There are two general methods of applying water softeners," and then go ahead with the remainder of the revision.

Mr. Dorley: This clause should be taken in connection with the other matter in the manual. I think the matter would be entirely clear if taken with the rest of the text.

Mr. Lindsay: Where does the Permutit system come in?

Mr. Dorley: It is a chemical.

Mr. Lindsay: Differing chemically from the soda lime process?

Mr. Dorley: Yes.

The President: Unless there is objection Article 7 will be accepted.

(Mr. Dorley then proceeded to read the paragraphs, embodying changes, by number.)

Mr. Lindsay: Referring to Article 5, page 444, of the manual, I think attention should be called to two important features of water-softening plants. One is that the machinery should not be easily deranged by sediment or corrosion and the other is that it ought to be easily cleanable. I would like to add to the suggested revision of Article 5 these words: "And not easily disarranged by sediment or corrosion and easily cleaned."

Mr. Dorley: I think that is implied in the words, "The mechanical apparatus should be simple in construction and operation." If it is simple in operation we believe that presupposes it is easily cleaned. We have been working toward brevity here. The suggested revision further says that the mechanical apparatus shall be "stable in adjustment." If it is stable in adjustment it is not easily disarranged.

The President: If there is no objection it will be assumed that is satisfactory.

(The chairman of the committee then read the various suggested revisions down to "Page 450 of the manual.")

The President: Changes will be made in the mannual in accordance with all the recommendations.

Mr. Dorley: The third subject is "Report on methods for rejuvenating driven wells; cost and success, as compared with driving new wells." All railways have before them more or less the trouble of dealing with water supplies secured from wells. We all know the driven wells first put down give a certain quantity of fixed water, but, due to fixed causes, the yield falls off. The causes underlying this falling off are quite numerous and the committee has attempted to outline these reasons. Perhaps 90 per cent or more of all well troubles are located in the bottom of the well, in the strainers, and the problem of repairing the well is necessarily tedious and expensive. This report is submitted as information.

The President: This will be accepted as information.

Hunter McDonald (N. C. & St. L.): The manual as now printed advises that we shall examine springs with a view to the possibility of future pollution, and the committee, in its revision of that subject, repeats that provision. I want to ask if it is the sentiment of the committee that in supplying water for locomotives the question of pollution should enter into it at all. We have had that question up and we have come to the conclusion that where we might get pure water, good for drinking, at some points, there are other points where it is absolutely impossible to get it, and we have decided to abandon altogether any effort to secure unpolluted water in our locomotives, and we expect to notify our men that water in the locomotives should not be drunk. I would like to ask the committee if they have considered that feature of it and if they will repeat this recommendation with that point in view.

J. L. Campbell (E. P. & S. W.): In that connection, we had a case on our road where, during the rainy season in the mountains, from which we have a supply of water from a spring, the floods, running down over the surface of the sides of the canyon, passed over gypsum beds and temporarily and periodically polluted that source of water. Consequently it became more highly objectionable for use and required a special degree of treatment during such time to make it acceptable for use in the boilers. I believe it is highly desirable to consider surrounding conditions of water supply in order to know whether or not you are liable to have it polluted.

Mr. McDonald: I move that the committee amend that clause so as to define what they mean by pollution. In other words, that the pollution applies only to boiler water and not to drinking water.

The President: The committee is willing to do that.

Mr. Dorley: No. 4—"Report on various types of well strainers in use and the service secured from each type." We all know that the most important part of any well is a strainer, if one is used. The report attempts to describe the various types of well strainers in use, their construction and the extent to which they are used. Nearly all well strainers were developed with a view to meeting some certain condition, and every well strainer on the market has its own particular field. When it comes to selecting a well strainer for any particular location very good judgment and experience is necessary to make the proper selection, because many wells have proven to be complete failures by reason of the poor judgment shown in selecting the particular type of strainer in the first place and then in selecting the proper mesh. The mesh can be too fine or too coarse, and either will lead to failure. This report on well strainers is for information.

The President: Unless there is objection, this will be received as information.

Mr. Dorley: Report No. 5, "On methods for complying with Federal regulations in regard to purity of drinking water supplied to the public and employes on interstate trains." In handling this subject the committee secured information of R. C. Bardwell, chemist of the Missouri Pacific at St. Louis. The report attempts to outline the steps of the health department in formulating these regulations, the methods followed and the attempts made by the various railroads to comply with them. The committee feels that as various changes and modifications can be expected in these regulations within the next few years that it should be instructed to keep in touch with the future developments of these regulations and make a report the next year or the following year. The report in its present form is offered as information.

The President: Unless there is objection, this will be received as information.

Mr. Dorley: Report No. 7, "Report on relative merits of continuous and intermittent water softeners," is offered as information.

The President: Unless there is objection, this will be received as information.

Mr. Dorley: "Report on rules or examination questions for care of boilers in pumping stations." The committee was somewhat in doubt as to what was to be included in this report, and have used an interpretation that was perhaps a little broader than was in the minds of the Committee on Subjects. An attempt was made to formulate a set of rules on the care of water stations of a kind that could be inserted in the Railway Book of Rules on Maintenance of Way. In addition, we include two sets of examination questions for care of water stations, first covering the steam plants, and the other on plants consisting of internal combustion engines, as the prime mover. On account of the fact that electrically-operated pumping units are coming into general use, we have also done some work on a set of questions covering care

and operation of electrical equipment, but this set of questions was not ready at the time the report went to the printer, and on that account this is offered as a progress report.

C. W. Baldridge (A. T. & S. F.): There are one or two cases here to which the committee's attention should be called for next year's work. Referring to the statement, "If there be a night attendant, he should be cautioned about any defects in the plant by the day man before leaving." It appears to me that this should be revised to read that "where more than one shift is in charge of the pumping plant, each oncoming man should be notified by the man leaving of any defects." The day man should be notified by the night man, the same as the night man by the day man.

Mr. Dorley: That is a good suggestion, and we will bear that in mind.

Mr. Baldridge: Referring to question 4, either the words "for gas or oil" should follow "needle valve," or "air" should be eliminated. You should designate what the valves are for.

Mr. Dorley: We accept that suggestion.

The President: If there is no further discussion, this will be accepted as information.

(The committee was relieved with thanks.)

Report of Committee on Electricity

THE following definitions are submitted for publication in the Manual:

THIRD RAIL.—The contact conductor placed at either side of the track, the contact surface of which is a few inches above the level of the top of the track rails.

THIRD RAIL TIE.—A long tie placed at regular intervals carrying the track rails and supporting the third rail.

THIRD RAIL PROTECTION.—A guard for the purpose of preventing accidental contact with the third rail.

THIRD RAIL FIXTURES.—Brackets, supports, hooks, bolts, lags, insulators, inclines, bonds and other special devices used in connection with third rail installations.

TRANSMISSION SYSTEM.—When the current generated for electric railways is changed in kind or voltage, between the generator and cars or locomotives, that portion of the conductor system carrying the current of a kind or voltage substantially different from that received by the cars or locomotives, constitutes the transmission system.

A: TRANSMISSION LINE AERIAL.—A structure of wires and supporting towers on which are strung cables or wires for transmitting high or low tension current, either d. c. or a. c.

B: DUCT LINE.—A structure consisting of one or more ducts laid up in banks and covered with a protective covering, generally concrete, in which wires or cables are placed for transmitting high or low tension current either d. c. or a. c.

SPLICING CHAMBER.—Chambers located at intervals in the duct line where cables are spliced and inspected.

PULLING CHAMBER.—A chamber similar to but smaller than a splicing chamber and used primarily for pulling cables and wires into ducts.

SPLICING CHAMBER AND PULLING CHAMBER FIXTURES.—Racks, supports, sleeves, shelves, sumps, pumps, covers, drains, etc.

DUCT.—A single tubular runway for cables.

MULTIPLE DUCT.—Two or more ducts molded in one piece.

JUMPER.—A cable used to connect the ends of two working conductors.

WORKING CONDUCTOR.—A contact rail or wire supplying propulsion current to locomotives or cars.

MAINTENANCE ORGANIZATION AND RELATION TO TRACK STRUCTURES

The following table shows the mileage of tracks electrically operated and includes both main tracks and sidetracks on railroads replying to the circular:

George W. Kittredge, Chairman

Third Rail ..... 706.89 Miles
Overhead Contact .....1,803.72 Miles

The introduction of electric traction has not necessitated any radical changes in the organization of the maintenance of way departments. The maintenance of the power stations, sub-stations and transmission systems has usually been placed under the supervision of the motive power department or of an electrical department, organized especially for the purpose, while the maintenance of the working conductors, positive and negative cables, track bonding, etc., is naturally placed under the maintenance of way department. The present tendency is to have the maintenance of the electrical track installation performed as far as possible by the existing maintenance of way organization with such additions thereto as the peculiar installations on each railroad may demand. The introduction of electric traction has not necessitated any material change in the length of track sections or in the force employed; those features being dominated by the density of traffic, rather than by the character of the propulsion power.

The presence of the third rail upon a track results in noticeable precautions being taken by employees walking and working thereon. This expresses itself in the first instance as timidity, but this fear soon wears off and the precaution necessary becomes a habit. Thereafter the reduction in efficiency and the liability of accident depend somewhat upon familiarity which breeds contempt. The absence of the exhaust and of escaping steam and the difference in the character of the whistle signals given is such as to render it necessary to exercise greater watchfulness for approaching trains upon an electrically-operated road. With the overhead system there is no physical obstruction or danger to the free movement of employees on the tracks, but these elements are transferred to the employees working on top of the equipment and on stations and bridges.

Wherever possible the third rail is located on the opposite side of the track from low platforms. Where the platform is sufficiently above the level of the running rails it is so designed that it projects over and protects the third rail and equipment shoe. Where the platform is level with the top of the rail and the third rail is located on the side of the track opposite from the platform, it is necessary to furnish some means of preventing passengers or employees from coming in contact with the shoes on passing equipment. This can be done by keeping the edge of the platform far enough from the rail or by marking in some suitable way a stripe upon the platform with suitable warning.

The presence of the third rail supported by a longer track tie, located on one side of the track, loads the ballast unequally and unless precautions are taken to tamp the third rail tie for its entire length, the track is apt to get out of cross-level irregularly and objectionably. The exact expense of overcoming this difficulty is not determinable.

The presence of the third rail has made necessary certain changes in the method of track work. The cost of renewing ties has been increased as much as 15 per cent. The well-established system of taking the old tie out on one side of the track and putting in the new tie from the other side must be abandoned, and the work entirely done from one side. The presence of the third rail renders difficult the withdrawal of the line of spikes adjacent thereto.

The renewal of the running rail is rendered more difficult by the presence of the third rail in that the old rail and the new rail must be handled on one side of the track opposite from the third rail. As the ties supporting the third rail are usually carefully located with reference to the joint in the running rail, so that rail joints do not come upon the third rail ties, the shifting of the rail by expansion and contraction or rail creeping, and the gain or loss in the location of the joint when replacing rail, necessitates greater care in the selection of rail and in the laying of it, to maintain the relationship of the rail joint to the third rail ties. The increased cost of relaying rail is estimated by some to amount to at least 15 per cent, on account of the physical obstruction of the presence of the third rail.

The distribution of ballast by plowing it off flat cars or unloading from side dump cars is impracticable where there is third rail, as it is liable to be damaged by the falling material, so that a system of distribution by center dump cars is necessary. Even with these precautions care must be taken promptly to level down the ballast below the plane of the running rails and beyond the possibility of contact with the third rail or with the shoes of the cars. The presence of the third rail interferes greatly with the operation of jacks on that side of the track, necessitating the use of jacks between the running rails under flag protection, which is not a satisfactory location for jacking the heavier side of the track. The added weight of the third rail and its appurtenances must also be lifted and care taken not to make the raise in the track so abrupt as to crack the insulators and attachments to the third rail. It is estimated by some that the cost of ballasting has been increased at least 10 per cent where the third rail is in use.

The presence of the third rail on a track makes it necessary to use the adjacent running rail as the line rail in all cases, as the gage between the running rail and the third rail must be preserved, so that, as the third rail transposes from one side of the track to the other, the line rail is similarly transposed. In gaging the track the line rail must be trued to line first and the opposite rail gaged from it.

The presence of the third rail requires the use of a jack between the running rails and its protection by a flagman. It also requires the foreman to do all his sighting from a position between the running rails with his head between the running rail and the third rail. On curves this is not always the best position for such work.

The use of the third rail has developed a number of special appliances, the most conspicuous of which is the tie tamping machine operated either by compressed air or electrically driven devices with power taken from the third rail. Another useful tool is the low jack, which can be placed between the rails, the lifting bar being of such length that the top of it does not project more than two inches above the plane of the running rail, thus reducing to a minimum the possibility of an accident from equipment striking the jack. This tool has a maximum lift of six inches and a capacity of ten tons. The presence of convenient power close to the track has permitted the development and general use of machines for grinding, boring and drilling, tightening bolts, driving spikes, tamping and similar work, formerly done by hand, and also the use of portable electric lights and electric track heaters for melting snow and ice at switches, etc.

The presence of the third rail has restricted the use of hand cars, truck cars, motor cars, etc., owing to the presence of the physical obstruction of the third rail on one side of the track, especially in multiple track layouts, where it is difficult, if not impossible, to carry such a car across from one track to the other. The increase in the density of traffic coincident with the introduction of electric traction is often a greater restriction upon the use of these small cars, and it is desirable in using such cars on the third rail system to do so only under orders or under flag protection.

The presence of the third rail requires special care and increased expense in the loading and unloading of rail, ties, frogs, switches and heavier material, in order to avoid damage to the third rail and its appurtenances, but no exact figures are available. The increase in cost is offset to some extent by the general use of machinery, such as derricks, rail unloaders and similar devices for such purposes.

On double-track layouts it is desirable to put both the third rails between tracks. Where there are more than two tracks the third rail should generally be located with the idea of keeping the third rails in pairs between the tracks. On sharp curves it is sometimes necessary to locate the third rail on the outside of the curve in order to avoid damage from the overhang of equipment. In any third rail system over which steam railroad equipment is operated, it is necessary to put up at strategic points a device for detecting and marking any equipment that will not properly clear the third rail in the territory which it is approaching and insure means for having such equipment removed from the train before reaching the third rail territory.

Where it is necessary to use a stock guard in connection with the third rail system, it is desirable to avoid the use of metal and the stock guard should project at least half its length beyond the end of the third rail. Stock guards of wood and vitrified construction are suitable for such locations.

With the overhead system it is practically impossible to afford sufficient overhead clearance at all points to clear an employee standing on the top of the highest equipment. To safeguard such employees, on one road a specially painted and illuminated warning sign is used. On another road all points on the main track with less clearance than 21 ft. 6 in. are bulletined and receipts obtained from all employees whose duties require them to come close to such wires. In yards all wires of less than 21 ft. 6 in. clearance are designated by illuminated signs reading, "HIGH WIRE" or "LOW WIRE." On another road warning of low clearance is given by bamboo poles, extending horizontally over the track, supported by a hinge device attached to the pole supporting the wire system, permitting lateral upward movement. The life of the bamboo is considerably shortened by the blows from the passing pantagraphs.

With either the third rail or the overhead working conductor the drawbridge presents a special problem to provide propulsion current without long gaps. Current can be carried to the draw pier by submarine cables and the working conductor on the drawbridge supplied with cur-

rent with a very small gap at the ends of the draw. Steel structures in bridges, viaducts, stations, etc., in close proximity to the third rail or overhead wires are exposed to the danger of injury by arcs created by short circuits and it is desirable that all such structures should be protected by a device to open the circuit breakers in case of a short circuit to the structure.

The flange wear on curves where multiple-unit equipment is used is believed to be greater than where steam equipment is used, estimated in one case to be as much as 25 per cent. The damage to the wheels is not so great as it is with steam operation. The corrugation of the running surface of the rail with multiple unit equipment is a noticeable detail, tending to shorten the life of the rail. As the trucks of multiple unit cars are generally heavier than the trucks of corresponding equipment in steam operation they are believed to be the cause of this corrugation in the process of accelerating and retarding the movement of the train. With electric locomotives the rail wear is believed to be no greater than with steam locomotives of equal weight and wheel base.

The greater proportion of the total weight in some designs of electric locomotives, which is below the springs, requires the maintenance of line and surface in better general condition than with steam equipment, and necessitates the design of the electric locomotives so as to control and restrict its lateral movements which otherwise might become of such magnitude as to injure or displace the track. These features of electric equipment have also brought about the strengthening of the details of spikes and tie plates, which has added to the cost of track construction, but which tends to reduce the cost of track maintenance. No appreciable effect is observed upon the first cost or maintenance of frogs, switches, crossings and other special appliances. The usual increase in traffic density, coincident with the introduction of electric traction, renders it difficult to segregate the increases in cost of maintenance due to the change in the type of equipment.

In most cases of electric installation the use of steam locomotives is continued to some extent, so that it has not been possible to determine the extent to which the cost of track maintenance has been modified by the elimination of the unbalanced reciprocating parts of the steam locomotives, but it is believed that there has been a decided gain in this respect where steam locomotives have heretofore been operating at high speeds and where such use of steam locomotives has been materially reduced.

On electrical installations there is a decided advantage from a maintenance standpoint because of the elimination of corrosion due to locomotive gases, absence of cinders and ashes, and the elimination of fire therefrom and the more cleanly condition of ballast.

Committee: George W. Kittredge (N. Y. C.), chairman; D. J. Brumley (I. C.), vice-chairman; Z. M. Briggs (P. L. W.), R. D. Coombs (Cons. Engr.), A. O. Cunningham (Wabash), Walt Dennis (C. R. I. & P.), R. H. Ford (C. R. I. & P.), George Gibbs (L. I.), G. A. Harwood (N. Y. C.), E. B. Katte (N. Y. C.), C. E. Lindsay (N. Y. C.), W. L. Morse (N. Y. C.), W. S. Murray (Cons. Engr.), J. A. Peabody (C. & N. W.), Frank Rhea (I. C. C.), J. R. Savage (L. I.), Martin Schreiber (P. S. Ry.), A. G. Shaver (Cons. Engr.), H. U. Wallace.

Discussion

C. E. Lindsay (N. Y. C., representing the committee): The first subject assigned is that upon revision of the manual. On this subject Mr. Harwood was the chairman of the subcommittee, but we are in receipt of a letter addressed by Mr. Gibbs to the president of the association, as follows:

"In the report of the committee on electricity there is a report of Sub-Committee No. 1 on Revision of Manual, of which I am a member. Neither Mr. Harwood nor myself will be able to be at the convention, and I note that the recommendations of the committee as a whole provide in No. 1 for the adoption and publication of the definitions of Sub-Committee No. 1. I would move that this recommendation be not adopted.

"The American Railway Association adopted as standard a number of years ago a list of definitions applying to third rail working conductors and that these definitions differ in some important respects from those proposed by the Committee on Electricity and that the American Railway Association's definitions are, in my opinion, more comprehensive, logical and concise than those herein proposed.

"A definition is given for 'transmission system,' but no definition is given for 'distributing system' or 'contact conductors' other than 'third rail conductors.'

"In a number of places the definitions use a term which has not been defined: For instance, 'duct line' is defined as 'a structure consisting of one or more ducts,' whereas, the word 'duct' is not defined until later. Also, in defining jumper the words 'working conductors' are used before the latter words are defined.

"I hope that the report of this sub-committee will be referred back to the full committee for further consideration before its adoption or printing in the manual."

I might say that I have not had time to confer with the other members of the committee who are present, nor do I feel warranted in accepting the suggestion of Mr. Gibbs, and therefore leave this subject to be acted upon as the chairman may think best. I move the adoption of Conclusion No. 1. (Motion lost.)

Mr. Baldridge: I move that the definitions included in this report be referred back to the committee for further action. (Motion carried.)

Mr. Lindsay: The second recommendation is submitted for publication, not in the manual, but in the proceedings as information.

The President: If there is no objection this will be accepted as information to be published in the proceedings.

Mr. Lindsay: The next is No. 3, "Acceptance and publication in the proceedings as information of the report of the American Committee on Electrolysis."

The President: This report on electrolysis is very elaborate and is a valuable report. If there is no objection, it will be accepted as information.

Mr. Lindsay: I move the adoption of recommendation No. 4.

The President: Unless there is objection to this it will be accepted as information.

The President: Without objection, recommendations 5 and 6 will be received as a report of progress.

Mr. Lindsay: The United States Bureau of Standards, Washington, has issued in the form of Bulletin 54 a tentative National Electrical Safety Code. This bulletin has been quite widely distributed and copies have been furnished to each railroad, both steam and electric.

The Bureau of Standards desires the active, systematic co-operation of steam railroads in this matter, and members of this association interested in the subject are urged to obtain a copy of the Code and send their comments or criticisms to Dr. E. B. Rosa, chief physicist of the Bureau of Standards at Washington during the year 1917.

(The committee was dismissed with thanks.)

Report on Wooden Bridges and Trestles

THE sub-committee to which was assigned the study of docks and wharves, submitted a general report last year showing a few typical designs that could be recommended as good practice under certain conditions. During the past year, after giving the subject much study, it is our opinion that owing to the variety of conditions under which these structures are built, it is impossible to submit a detailed report that would be of value. Making a comparison of costs between different styles of docks as to whether it were better to use a temporary or permanent form or some combination of the two depends so largely upon the many variable conditions of the site and the traffic to be handled that arriving at correct conclusions is a matter to be decided by careful study of each individual case. The committee recommends that the study of this subject be discontinued, but as much valuable data has been gathered in the study of the subject, the committee is having prepared, under the direction of Mr. Hoyt, a paper dealing with the subject which it purposes submitting to the board of direction for printing in a future bulletin of the Association.

E. A. Frink, Chairman

Comparative Merits of Ballast Deck and Reinforced Concrete Trestles

The minor, although not necessarily decisive, factors entering into a comparison of the two types of structures may be stated to be: (*a*) Fire hazard. (*b*) Stability against the action of floods. (*c*) Service qualities. (*d*) Appearance, and (*e*) Conservation of materials.

The two major or determining factors to be discussed are: (*f*) Statutory requirements and (*g*) Ultimate economy.

In recorded instances of loss by fire of ballast deck wooden trestles the conflagration has with few exceptions originated below the deck, the ballast serving as an effectual fireproofing measure in the structure proper. While some of these cases are the resultant acts of careless or maliciously inclined persons, the far greater number are caused by locomotive sparks igniting an accumulation of inflammable debris directly under or adjacent to the bridge. It therefore follows that for carrying traffic over bodies of standing water, or streams of continuous flow, there is little, if any, fire hazard in the maintenance of ballast deck trestles, and that if the surface underneath and adjoining bridges over dry washes, gulches and watercourses of intermittent flow is kept clear of inflammable material the danger of fire loss is inconsiderable. However, it should be recognized that wood in any form is combustible while concrete is immune against fire, wherefore advantage in this respect must be assigned to the reinforced concrete structure, the degree thereof depending upon the character of opening to be bridged and thoroughness of roadway maintenance, as above suggested.

The preponderance of opinion is that with equally secure foundations regardless of cost, there is less danger of loss by flood with the concrete than with the timber structure. It is possible that destruction of a concrete trestle will leave the opening so congested with masonry debris as to render installation of a temporary bridge difficult and expensive, and it is quite certain that flood destruction in case of the concrete structure will entail a greater monetary loss. The lighter specific gravity of wood as compared with concrete places the timber structure at a decided disadvantage in case of abnormal floods. The buoyancy of the water, coupled with its force as a current might carry away a wooden structure where a concrete trestle of the same waterway would withstand the assault. In bridging openings over standing water, not subject to surface fluctuations, neither type can have an advantage over the other type in this particular respect, for in such event the flood element is not present.

In considering relative service qualities of the two types of structures the object was to ascertain if there might not be some difference in the manner of performance of the function for which they were created, namely, that of carrying traffic. Opinion is about equally divided as to whether or not either type displays better behavior under traffic than the other, the greater weight of evidence favoring concrete where any difference of opinion is expressed.

The great similarity from a viewpoint above the track renders it practically impossible for passengers on trains of a common carrier to distinguish the one type of ballasted structure from the other. In municipalities and congested districts, where railway structures play a part in civic improvement and where esthetic features are desirable, concrete is decidedly preferable to timber, but usually in such instances no discretion can be exercised and therefore no choice is permissible. Hence it is evident that in a comparative analysis of this sort the assignment of merit in the more sightly appearance of concrete is without justification.

For the design and construction of engineering works the selection of either of two materials equally available in requisite quantities should be governed by their relative adaptability to the contemplated purpose and for the particular service to be rendered by such structures. If it should appear that either of two materials equally satisfactory for desired purpose or service requirements is better suited for some other use, then that material should be conserved for the particular purpose for which it is pre-eminently fitted. Wood and concrete apparently lend themselves with equal facility to the construction of trestles of moderate height, but there are many uses for which wood is vastly more suitable than in the construction of bridges. In fact, there are urgent demands for material which timber alone will fulfill, and while the same may be true of concrete, yet the occasions where it is indispensable are not nearly so numerous. Again wood is perishable and concrete durable. The supply of the perishable can only be replenished in long intervals while the durable is manufactured with small probability of exhausting the supply of elements used in its production. We, therefore, err in the installation of wood when concrete will answer, provided all other factors of influence are equal. The degree of advantage which should be credited to the concrete structure in this respect evidently cannot be expressed in definite values.

Investigations have been conducted to ascertain if there are extant in any of the states mandatory laws necessitating the installation of concrete structures. The committee is unable to cite any instances of this kind and finds that mandates for such construction are issued only

by Public Service Commissions, or other regulating authorities. Mandatory elimination of highway grade crossings generally requires expressly or by implication the use of durable material, and for this purpose when short spans are permitted concrete is superior to all other materials.

A comparative statement of costs of installation and maintenance in perpetuity of the two types of trestles will be evidence of their relative ultimate economy. The greatest difficulty has been experienced in ascertaining even a fairly representative figure of cost of installation of either type, and absolutely no accurate statements of cost of maintenance are available. Few roads are extensive users of both kinds of structures, and cost data furnished by lines traversing the same or similar territory show so wide a divergence even for the same kind of trestle that a basis for comparison is impossible. The ratio of installation cost of concrete to that of wood, as reported to the committee, varies from 1.35 on one road to 2.50 on another, while the maximum ratio as obtained from all data submitted is 4.20. Neither type of structure has been in service a sufficient length of time to determine annual maintenance expense throughout its serviceable life.

Next to cost of installation, length of life is the prime factor in ultimate economy, hence it follows that a comparison, to be of any value, must be based on the number of years' service each type will furnish. The best authorities on the timber structure are pretty well agreed that the creosoted trestle will last 25 years, although there are no definite data to corroborate, while an assertion as to the lifetime of the concrete is mere conjecture, some venturing an opinion of 50 years, some 100 years, and others longer periods. It has been suggested, and quite properly, that owing to the rapid changes now taking place in the industrial and transportation developments of the country, durability of material in railway structures of this kind is not the sole criterion of longevity, and that a life of 50 years at most should be considered permanency. These uncertainties, installation cost, length of life, and annual maintenance charges, compel the submission of interdependent figures, for it is clear that the committee cannot prescribe for adoption by the various railways values for any one of the uncertain elements. If, however, there can be shown the relative ultimate costs of the two types as dependent upon service life, the result will doubtless be of more general utility than one fixed relation designed for universal application. This the committee has attempted to do, and as a result submits in Appendix A statements of comparative ultimate costs.

Table No. 1 assumes the life of creosoted timber trestles to be 25 years, and shows for any installation cost thereof from $10 to $20 per linear foot the corresponding expenditures justifiable in the installation of concrete, which is expected to serve for various periods from 30 to 100 years. Table No. 2 gives the same information on a basis of 20 years' serviceable life of the timber trestles. Both statements are computed with annual interest at 6 per cent, neglecting the indeterminate element of maintenance expense. In other words, the figures show first costs of both types of structure requiring an equal capital investment for initial installation and maintenance to perpetuity.

In Table No. 1, for example, it will be seen that instead of spending $10 per linear foot for a timber trestle to serve 25 years, $12.33 per linear foot could with the same outlay of capital be expended for a concrete structure lasting 50 years, $12.82 for one serving 70 years, and $13 for one requiring renewal in 100-year intervals. Likewise where the construction of a timber trestle with a 25-year life cost $20 per linear foot, a concrete trestle with a 100-year life must be constructed for $26 per linear foot to produce the same capital investment, and in this discussion capital investment is intended to mean actual cost of installation plus a sum which, placed at 6 per cent interest, compounded annually, would provide for complete renewal of the structure at the end of its life.

The fallacies in the argument for thus showing ultimate economy consists in the omission of the previously mentioned indeterminate factor of annual maintenance expense, and also the unknown price of materials and labor at the future date of renewal. It is for this reason that Table No. 2 was compiled, wherein the life of the creosoted timber trestle is fixed at 20 years. Reduction of the assumed life of the wooden structure from 25 to 20 years is considered adequate to cover the uncertainties in increased price of timber and in the matter of maintenance. We therefore think Table No. 2 the better as being more nearly representative of actual conditions.

Attention is directed to the principal fact disclosed, namely, that unless the cost of creosoted timber trestles is unusually high and reinforced concrete correspondingly low there will be no ultimate economy in the use of concrete even should it attain a life of 100 years.

In view of all of the foregoing we believe certain conclusions warranted as recited in the following summary and recommended that these be printed in the Manual, together with Tables Nos. 1 and 2, shown in Appendix A, and the formulas shown in Appendix B.

Conclusions

(1) While in certain locations there is little probability of fire loss in creosoted ballast deck timber trestles, yet due to the very nature of the material used the reinforced concrete trestle has a decided advantage.

(2) The concrete structure is slightly superior to the timber structure for bridging waterways subject to flood currents, or wide fluctuations in elevation of water surface.

(3) Although the concrete trestle may possibly afford better service qualities than the wooden trestle, the matter is so intangible in character as to preclude a definite statement of relative merit.

(4) Where selection of type is optional and not influenced by other considerations, neither type of trestle has the advantage of the other in the matter of appearance.

(5) Notwithstanding the fact that the two materials are, with certain limitations, equally suitable for the construction of trestles, the use of concrete is more in accord with the theory of conservation of natural resources and industrial economy.

(6) Creosoted timber trestles are more economical than concrete, except when the cost of the concrete structure is less than one and one-half times the cost of the wooden structure.

(7) Adoption of either type should be the result of carefully weighing, for each individual bridge, the greater economy of the timber trestle against the several advantages of the concrete not susceptible of mathematical demonstration.

Lag Screws for Fastening Guard Timbers

The subject of lag screws for fastening guard timbers to ties on bridges and trestles has been under investigation since 1914. The first year's investigation was devoted to ascertaining how extensively lag screws were being used by the various railroads. A large number of roads have been using them with good success, but there

seemed to be no uniform practice as to their purpose or manner of application. It was decided by the committee to try to interest other roads in the use of lags and for the purpose of comparison a plan of general application was prepared and sent to a large number of roads. This plan was accomplished by a general letter of instructions with the aim in view of interesting as many roads as possible in a uniform test to be made. A hearty response was received in answer to the request.

On July 18, 1916, a request was sent to 34 roads, which had indicated their willingness to aid in the test. Various causes prevented a number of these from continuing the actual test; and as a result but 15 roads were in position to report on the matter in response to a letter sent them under date of December 7, 1916. With one exception the results of tests are giving good satisfaction. Replies indicate that it will take more time to formulate a reliable report. One of the requisites of efficiency of the test appears to be the ability to withstand derailments of wheels without serious injury to the deck of the structure; or to withstand strains equivalent to the old method of dapping guard timbers and ties with a bolt through both about every third or fourth tie. Until sufficient time has elapsed to determine the results of the tests now in progress, no definite conclusions can be drawn. The committee, therefore, deems it necessary to proceed with the tests and recommend that the subject be continued.

Merits of Galvanized Iron Fastenings for Timber Trestles

The committee sent out inquiries to officials of a number of railroads and creosoting companies and individuals to obtain information regarding the durability of plain iron or steel fastenings in creosoted timber trestles as affected by the creosote oil, also whether other causes, such as brine drippings from refrigerator cars, or when the trestle is located over salt water, would tend to decrease their life below that of the timber. Information was also requested as to whether galvanized iron fastenings should be used in creosoted timber trestles instead of plain iron or steel fastenings.

Seven replies were received from officials of creosoting company officials, 15 from railroad officers, and four from individuals. Based on the information contained in these letters the committee makes the following conclusions, which it recommends printing in the Manual:

Conclusions

Creosoted timber has a tendency to protect from corrosion any plain iron or steel fastenings which are imbedded in the timber.

The durability of such fastenings is at least equal to that of the creosoted timber used in trestles.

In the use of timber treated with straight creosote, drift bolts or other fastenings being entirely covered by the timber, it is good practice to use plain iron or steel.

Such fastenings as are exposed to the action of brine drippings may be galvanized, but the information as to the increased life of fastenings so treated is not sufficient to state definitely that the expense of galvanizing is justified.

It is not necessary to use galvanized fastenings in creosoted timber structures over salt water.

Committee: E. A. Frink (S. A. L.), chairman; W. H. Hoyt (D. M. & N.), vice-chairman; F. Auryansen (L. I.), H. Austill (M. & O.), H. C. Brown, Jr. (Ch. Br. & Iron Co.), A. D. Case (B. & A.), E. A. Hadley (M. P.), G. A. Haggander (C. B. & Q.), F. F. Hanly (B. & O.), C. S. Heritage (K. C. S.), H. S. Jacoby (Cornell Univ.), F. L. Nicholson (N. S.), A. O. Ridgway (D. & R. G.), F. S. Schwinn (M. L. & T.), C. S. Sheldon (P. M.), I. L. Simmons (C. R. I. & P.), D. W. Smith (H. V.), A. M. Van Auken (M. C.), D. R. Young (D. L. & W.).

Appendix A.

Table No. 1.—Comparative cost of installation of ballast deck trestles per linear foot to produce equivalent economic value—interest at 6 per cent per annum—assuming creosoted timber trestle will serve 25 years:

Creosoted Timber Service Life 25 Years	Justifiable Expenditure for Concrete Serviceable for							
	30 Years	40 Years	50 Years	60 Years	70 Years	80 Years	90 Years	100 Years
$10.00	$10.77	$11.74	$12.33	$12.64	$12.82	$12.91	$12.97	$13.00
11.00	11.84	12.91	13.56	13.91	14.10	14.20	14.27	14.30
12.00	12.92	14.00	14.80	15.17	15.38	15.49	15.56	15.60
13.00	14.00	15.26	16.03	16.44	16.66	16.78	16.86	16.90
14.00	15.07	16.44	17.26	17.70	17.94	18.07	18.16	18.20
15.00	16.15	17.61	18.50	18.96	19.23	19.36	19.45	19.50
16.00	17.23	18.79	19.73	20.23	20.51	20.65	20.75	20.80
17.00	18.31	19.96	20.96	21.40	21.79	21.94	22.05	22.10
18.00	19.38	21.13	22.19	22.76	23.07	23.24	23.34	23.40
19.00	20.46	22.31	23.43	24.02	24.35	24.53	24.64	24.70
20.00	21.54	23.48	24.66	25.29	25.63	25.82	25.94	26.00

Table No. 2.—Comparative cost of installation of ballast deck trestles per linear foot to produce equivalent economic value—interest at 6 per cent per annum—assuming creosoted timber trestle will serve 20 years:

Creosoted Timber Service Life 20 Years	Justifiable Expenditure for Concrete Serviceable for							
	30 Years	40 Years	50 Years	60 Years	70 Years	80 Years	90 Years	100 Years
$10.00	$12.00	$13.09	$13.74	$14.09	$14.28	$14.39	$14.46	$14.49
11.00	13.20	14.39	15.12	15.50	15.71	15.83	15.90	15.94
12.00	14.40	15.70	16.49	16.91	17.14	17.26	17.35	17.39
13.00	15.60	17.01	17.86	18.32	18.57	18.70	18.79	18.83
14.00	16.80	18.32	19.24	19.73	20.00	20.14	20.24	20.28
15.00	18.00	19.63	20.61	21.14	21.43	21.58	21.68	21.73
16.00	19.20	20.94	21.99	22.54	22.86	23.02	23.13	23.18
17.00	20.40	22.24	23.36	23.95	24.28	24.46	24.57	24.63
18.00	21.60	23.55	24.74	25.36	25.71	25.90	26.02	26.09
19.00	22.80	24.86	26.11	26.77	27.14	27.34	27.46	27.53
20.00	24.00	26.17	27.48	28.18	28.57	28.77	28.91	28.98

Appendix B.

Comparative Economic Value of Ballast Deck Trestles

w = Cost of wooden trestle.
c = Cost of concrete trestle.
r = Rate of interest.
m = Life in years of wooden trestle.
n = Life in years of concrete trestle.
x = Amount capitalized which will replace wooden trestle every m years.
y = Amount capitalized which will replace concrete trestle every n years.
f = Ratio of first cost of concrete trestle to first cost of wooden trestle to produce equal ultimate economy, that is

$$f = \frac{c}{w} \text{ or } fw = c$$

Then $x\,(1+r)^m = w + x$ and $y\,(1+r)^n = c + y$, whence $x = \frac{w}{[(1+r)^m - 1]}$ and $y = \frac{c}{[(1+r)^n - 1]} = \frac{fw}{[(1+r)^n - 1]}$.

To produce equivalent ultimate economy $w + x = c + y$, which by substituting values of x and y gives

$$w + \frac{w}{[(1+r)^m - 1]} = fw + \frac{fw}{[(1+r)^n - 1]}$$

Dividing by w and solving for f it is found that

$$f = \frac{1 + \frac{1}{[(1+r)^m - 1]}}{1 + \frac{1}{[(1+r)^n - 1]}}$$

which is variable only with respect to m and n, the assumed lives of wood and concrete. By using as an argument the first cost of a wooden trestle with a constant life regardless of such cost, the first cost of a concrete trestle with a life of n years is found by applying to cost of wooden trestle the co-efficient f determined for n years.

Discussion

E. A. Frink (S. A. L.): With regard to Subject 1, revision of the manual, the committee has no recommendations to make for revision this year. We did, however, discuss the question of getting the revisions to the manual before the members more quickly than they are being gotten to us now. Of course, under the present method of handling the manual, that is impossible. We cannot afford to reprint the manual every year. That is plain. This is offered as a suggestion by the committee, and will be handled by the Board of Direction if they see fit.

Under Subject No. 3, "Comparative merits of ballast deck and reinforced concrete trestles, taking into consideration the design of ballast floors for timber trestles," the first five conclusions were presented in order and in each case on motion of Mr. Frink they were adopted for printing in the manual.

Mr. Campbell: I would like to ask the committee if they have considered to what extent conclusion No. 6 would eliminate the construction of wooden structures.

Mr. Frink: Legal requirements or appearance in certain locations, or too much money or things of that kind might have to be considered.

A. F. Robinson (A., T. & S. F.): It seems to me it would be of interest if the committee would show the figures on which it has based this statement. Have you made any figures on that, or have you just jumped at it?

Mr. Frink: We have made them, as you will find in one of the appendices. There are two tables giving various grades of creosoted trestles; that is, where the creosoted timber in the trestle costs $10 per foot and you figure it will last 25 years, it will pay you to pay $12.82 per foot for a concrete trestle, which you think will last 17 years; if you think it will last 100 years, it will pay you to pay $100 for it. We have another one, based on 20 years' life, that is on the assumption that the timber is well creosoted.

The President: I would like to ask Mr. Frink if, in arriving at these conclusions, any attention was given to statistics of loss by fire.

Mr. Frink: Yes; we paid attention to these statistics as far as we could. The sub-committee gathered all the reports they could of losses by fire, but we found in all cases but one that the fire originated underneath. There was one case reported of a timber ballast deck trestle which caught fire from live coals.

Mr. Campbell: I think it would be of interest to have the committee make a statement of what is meant by "concrete trestle," whether a trestle or a concrete bridge with reinforced concrete slabs on concrete piers.

Mr. Frink: I don't see that it matters whether it is reinforced concrete trestle or bridge. We show where you can build a reinforced concrete structure carrying track, be it bridge, arch or what, at a certain percentage over the cost of timber structure. It seems to me that covers the whole ground. Of course, we could divide that into reinforced concrete trestle; slabs on piers and abutments; and arches, but I don't think we would be any better off than now.

Mr. Robinson: There should be some study made as to height, because of fire danger and because of the time necessary to build the false work after a fire. I think the committee has worked on those that are not more than 20 ft. high. Isn't it possible that the conclusions would apply without their using higher structures? I might add that we have over 300,000 linear feet of ballasted deck bridges of creosoted timber.

Mr. Frink: In regard to the height, the creosoted pile ballasted deck trestle is limited in height to about 20 ft. Each kind of construction has its own limitation.

Mr. Robinson: What I am driving at is this: Your allowance of 150 per cent excess in cost of the concrete bridge over the timber bridge is based, I take it, on the figures made for bridges not over 23 ft. high. Would your figures apply to greater heights?

Mr. Frink: They would not. Our ratio of one and one-half is merely a rough approximation.

H. R. Safford (G. T.): It occurs to me from what has been said it might be well to omit paragraph 6, referring to the economical side of this question, until there is more data.

Mr. Frink: I hope that motion will not prevail. Conclusions 6 and 7 are the meat of this report. Take out those conclusions and the report will not amount to anything. If you can show the conclusions are wrong, the committee will be glad to be corrected.

Mr. McDonald: I do not know whether what I have to say is entirely germane to conclusion No. 6, but I think it will refer to all these conclusions to some extent. We have been users of ballasted deck trestles built of creosoted timber piles on old red cedar piles and on solid concrete bents that are built on the stub ends of oak and red cedar piles which have been cut off under the ground. We have perhaps three or four miles of such trestles, and I have yet to find one of these that has given us any trouble from fire. We cover the upper deck with old galvanized iron, giving us absolute protection against fire from above. The fact that the deck is solid keeps vegetation growing to a large extent, and the danger from fire below is eliminated. In that way the risk is practically eliminated, depending on the care of the section man. We build our timber trestles all the way from 6 to 55 or 60 ft. high, with single length creosoted piles. There is one note of danger that I want to sound and that is about the effect that the various drainage schemes in the South are having on the question of pile trestles across low areas. They are running these canals in all directions and lowering the drainage to a large extent, and in doing so they are making it possible to fill a large number of trestles over these hollows that formerly were considered absolutely necessary.

Now, if we can build creosoted timber trestles for $18 to $22 a foot, as we do, we hardly feel we are justified in spending $33 a foot for concrete trestles, which may inside of five or six years prove to be useless on account of the fact that a drainage ditch has run up the hollow and lowered the drainage and enabled you to fill the hollow. It may be you could recover that part of your ballasted deck which consisted of the slabs. You could not recover the pile substructure. Neither could you do so very well with creosoted timber, but I think the recovery of the creosoted stringers is much more likely than the recovery of the slabs.

I think we ought to be very careful in laying out our work from now on across low bottom lands, and

figure very far ahead as to whether we want to treat these structures in a permanent, or in a temporary way.

J. G. Sullivan (Can. Pac.): I agree with the chairman that if these figures are correct the conclusion is correct, but I would like to ask one or two questions. How do you figure for the fund for renewal? Is that a sinking fund?

Mr. Frink: Yes.

Mr. Sullivan: If that is a sinking fund at 6 per cent where do you get 6 per cent? You cannot get it from a bank. I think there is a joker in that. If you can figure a sinking fund at six per cent, you can do lots of things. If you figure that at 3 per cent, which will be conservative, you will get a different result. Have you figured anything for the work that does not cost anything, that is done by the section men? You do not have to pay anything for cleaning the trestle, if you have a concrete trestle.

Mr. Frink: As far as maintenance is concerned, we have not observed the cost of maintenance on either structure. There may be a little extra clearing of the railway necessary on the ballasted deck trestle. On the concrete trestle none would be required, and all the work you would have to do is the track work, which would have to be done in any event, irrespective of the type of trestle.

Mr. Sullivan: It is a small amount, but if only 10 cents or 15 cents a year per lineal foot is added, that will pay interest on a lot of money. I am afraid that you are comparing these charges with the capital rather than with the interest per year. When you get down to 20 years and see the amount of money that it is necessary to set aside it is infinitesimal. It does not take much money at 6 per cent to create a fund in a hundred years.

Mr. Frink: Without having gone into that question from that point of view, it seems to me that if you change the percentage in that way it will make the showing worse than it is now.

Mr. Sullivan: I do not think it will.

Mr. Frink: I am free to confess the committee has used 6 per cent in both of these tables, and at this moment we feel that is right. If the Association wishes it, we will go into that further.

J. L. Campbell (E. P. & S. W.): I think it is obvious that the comprehensiveness of these figures and their value depend upon the range of data included in this investigation. I think it would have been very desirable if the committee could have stated definitely the dimensions of these structures, especially with regard to their height; and it is quite possible by varying that height sufficiently that you would find there was quite a variation in the conclusions.

On the El Paso & Southwestern, we think the concrete bridge is a very good structure. We are building quite a number of them and we intend to build more on the basis that our creosoted ballasted deck wooden bridge is costing us $18 or $19 a lineal foot and the concrete bridge from $30 to $35 a foot, depending on its height. That concrete bridge has a span of 14 ft., center to center of piers, and its slabs are carried on piers and not on bents. The piers are two feet thick. We have not thought of building a concrete structure to a height greater than 15 ft. Of all the bridge structures we consider that the best.

Of course, we do not consider this concrete bridge as of general applicability. In fact, we think that there are many of the waterways on our road where such a structure is not suitable, and we are not building them there. On the other hand, there are many situations where that form of bridge is peculiarly adapted to meet the conditions satisfactorily.

We have a lot of creosoted bridges, built of yellow pine, all very good structures, especially the structures that we have built during the past 10 years, and we are having practically no trouble with them. Yet we are getting along to a point where we are having to give some attention to these structures and we are including all of them now in our regular annual inspection, whereas for a number of years we let them go. On some of the bridges built 14 years ago we find some of the creosoted piles are beginning to decay. I anticipate that is due to the fact that these piles had begun to decay before they were treated. We have no reason to believe that a thoroughly sound stick of timber properly creosoted will decay, yet we find as time goes on, that many things develop in connection with wooden structures that involve expense. We do not see where any expense will arise in connection with the concrete structure.

Mr. Frink: Referring to Mr. Sullivan's criticism of the per cent, before we worked out that table on the basis of 6 per cent, we worked out a table on the basis of 5 per cent and we concluded afterward that it was not right and did not use it. In our 5 per cent table, based on 20 years, the creosoted timber trestle cost $10 per foot, and that comparison showed that the concrete trestle for 100 years would cost $13.57 per foot. In the 6 per cent table the similar figure is $14.49. Therefore, our 6 per cent table is more favorable to the concrete trestle than the 5 per cent table. If you made it 3 per cent, it would be still more unfavorable.

Mr. Sullivan: I am figuring on the sinking fund. I think you are right with regard to the 6 per cent charges on your interest investment. My criticism would apply just the same to the 5 per cent rate, because you are still too high on the sinking fund rate. I would use two different rates, one 5, 6 or 7 per cent for interest on the first expense, and then figure the sinking fund at a different rate.

Mr. Frink: What I was going to say further is this—these conclusions are purely mathematical. They are not based on data collected. They are based on nothing but the comparative value of the two types of structures costing certain amounts per foot at the end of a certain term of years. It does not seem to me that it matters particularly whether you use 6 per cent or 5 per cent, or a sinking fund rate of 3 per cent or 2.5 per cent. The measure of the value of the concrete as compared to the timber structure is the same in either case. The tables were prepared simply to show what the justifiable cost of a concrete trestle was in dollars and cents compared with a ballasted deck trestle, and to that concrete cost you must add whatever you consider justifiable for the other five considerations which we term the minor considerations, such as fire hazard, etc.

A. F. Robinson (A., T. & S. F.): I simply wish to ask about the interest. I presume it is compound interest.

Mr. Frink: That is right.

Hunter McDonald: There was one other point I intended to mention. In the sandy regions of that part of the country through which our road runs, we find the valleys are filling up lately by the sand which is eroded from the banks, and every 10 years we must lift our entire roadbed up from the bottom of the valley to keep it from being overflowed. We believe under conditions of that kind it is a mistake to build an absolutely permanent structure there. Such conditions

are likely to develop at points where you least expect them. They frequently appear very suddenly, and we find our roadbed across these valleys is just being covered by the sand being washed down from the hills. Under these conditions if we had an absolutely permanent structure in the valley, we would suffer considerable loss, and that would be true in the case of a trestle constructed out of concrete piles and concrete slabs across a situation of that kind. In such a case there would be more risk of loss than there would be in the case of structures built out of timber, where they could be lifted up more rapidly.

C. F. W. Felt (A. T. & S. F.): An important factor in conclusion No. 6 is the relative life of the two kinds of structures, and unless that ratio can be definitely fixed we cannot draw a definite conclusion. I hope, therefore, that the ratio will not be fixed at one and one-half times.

Mr. Frink: On that point, you will notice that both of our tables give varying periods, from 30 years to 100 years. That is not intended to convey in any sense the idea that a concrete trestle will not last more than 30 years, or more than 100 years. Those figures were selected because, as Mr. McDonald so well said, conditions may arise at any time when a structure has to be removed. We have taken 25 years as the period of permanency for a railroad building. That applies, to a greater or lesser extent, to other structures. In the case of a trestle you may want to limit to 30, 40 or 50 years. We give the two tables to show what expense is justified, depending on the life.

Mr. Felt: The tables are all right, but this conclusion fixes a definite duration. I have no objection to the tables. They are of distinct interest, but this conclusion is based on a definite ratio of the life of the two kinds of construction.

Mr. Frink: That is true, but the ratio is slightly larger than 100 years' life for a concrete structure, and we did not think anyone would want anything longer that that.

J. C. Nelson (S. A. L.): We built some trestles of concrete some 6 or 7 years ago and have not spent a penny on them. I was asking my general bridge inspector a few days before I left home for some information about these bridges. He said he could not see that they had changed one iota from the day they were constructed, in any respect—there was no settling or vibration. He watched several freight trains pass over the bridges with our heaviest engines, having 52,900-lb. axle load, and remarked that he could not feel any vibration or notice anything at all in the action of the structure.

I have known of cases where ballasted deck trestles constructed by members of this association were put in as far back as 1876. I refer, in particular, to the Louisville & Nashville. I think Mr. Courtenay or Mr. Montfort a few years ago, when this question was under discussion, related the condition of these trestles, and stated that they had strengthened them by putting in untreated timber on top of the old timbers and that these timbers had been in for 10 or 12 years, and that neither the treated or the untreated timber had shown any deterioration. The New Orleans & Northeastern built an open-deck pile trestle of creosoted timber across Lake Ponchartrain, which was constructed in November, 1883. That trestle is still in use—a portion of it has not been filled—and about four years ago they cut out sections of the treated stringers and had them tested for strength in comparison with the best long-leaf yellow pine stringers that they could secure at that time, and they found that the treated stringers were stronger than the untreated, even though they had been in service some 29 years. I think the period of 20 years is too low. We expect to get 40 years out of ours.

A. Irwin (C. M. & St. P.): I would like to ask the chairman with reference to the service tables, whether this Conclusion 6 would apply under Table 1. Under Table 2, as I understand it, it is practically 100 years for the concrete trestle, with a service life for the creosoted trestle of 20 years. If the creosoted trestle were 25 years, what would be the advantage of the concrete structure, when this ratio would be one and one-half?

Mr. Frink: I cannot answer that question. The committee has not worked out the tables any further than they appear. As you will note from the formulæ, it requires quite a little calculation to work out these values and we have only worked out the ones which appear in the tables—it will be surely less than 1½.

Mr. Irwin: This whole thing appears to me an academic subject. One of the speakers referred to the fact that this conclusion is based on certain assumptions of age. With those assumptions the conclusion is all right. If the conclusion will state that the assumptions contained in it are based on a service life of 20 years for the creosote structure and 100 years for the concrete structure, there certainly is no objection to that. The other questions of practicability, etc., do not enter into it. It is purely academic. The unfortunate thing about the conclusion is that it leads one to believe that you are setting some laboratory ratio of value between the timber structure and the concrete one, which is not the case as I understand it. Therefore, if this Conclusion 6 were stricken out entirely and merely a reference made to this tabular statement in regard to the comparative cost of these two types of structures, you would have the meat of the whole thing.

S. S. Roberts: Any economic consideration of the life and cost will be governed by experience and our knowledge of different structures. That comparison can be had only by the formulae the committee used, or some other similar formulae. If the committee has made a comparison of a sufficiently large number of each type of structure and has had under consideration cost data on these structures, and estimates of their life based on experience in respect to all the practical points which have been brought up, then I am very much in favor of the conclusion of the committee, because I know the formulae to be reliable.

In response to one of the speakers, I will say that the formulæ that the committee has used may be so transposed that if you take the life of your ballasted floor trestle and its cost, and the cost of the concrete trestle, then you can show what life that concrete trestle must reach in order to be economical, and I think by quoting that formula you can answer a number of questions. I also think it might show the point the chairman brought out, that the life of the structures will have to be so much longer than we can foresee.

J. G. Sullivan: I am afraid I gave the impression I was opposed to creosoted piles with ballasted deck. That is not the case. I want to correct one or two misinterpretations which have been put on my remarks. One of them is with reference to cleaning out the trestles. We clean out under our wooden trestles, that is, remove the vegetation, and you will have to do the same thing under a creosoted trestle bridge. You do not have to go to that care with a concrete trestle and I still maintain there is a factor in there which should be calculated.

Another point—there is no doubt in the South, where there are long trestles, this is a vital subject, but if this conclusion is adopted, we will have to explain why we are building concrete trestles instead

of creosoted pile trestles, and I would like to know what my answer would be.

We are building concrete trestles costing $35 a foot, and we are building some as high as 36 ft., and bracing them with reinforced concrete, and we are doing that because they are more economical than abutments for steel bridges.

You might carry this a little further and it would be probably just as well to erect steel bridges with concrete trestle sills, and I think there are a great many places where it would be more economical.

G. A. Haggander (C. B. & Q.): It depends on the amount of money you have to pay for the material, etc. On the Burlington we have our own gravel pits and get that material very cheaply. We have been using this construction for 10 years. This form of construction becomes cheaper all the time, because we make our material in a central plant. We make large quantities of it and build these concrete pile trestles sometimes as cheap as $26 a foot. It runs from that up to $40, depending on the length of the trestle. You can build a very long trestle for $26 or $28 a foot, and the very short ones run higher than that. If you go into trestles 20 ft. high you must have concrete piers and that runs the cost up a good deal more than the figures I have given, of course. We consider the permanent feature of the trestle and the freedom from fire hazard as being worth a great deal to us, and that was one of the principal elements in mind when we built them. We think these two elements are worth a lot of money.

F. L. Thompson (I. C.): The first concrete trestle we built was supported on piers, and it was constructed in 1904. We have not spent a cent on repairs to that bridge since that time. We built a number of trestles each year without piers up to about four years ago. About three years ago, on a piece of second track, we built in four months 12,000 lineal feet of straight concrete pile trestle, and build now from 8,000 to 10,000 ft. of pile trestle each year. At the same time we are putting in 15,000 to 18,000 lineal feet of creosoted trestle a year. In the cases where we put in the concrete trestle we take into consideration the traffic which is carried over the line, the possibility of grade reduction, the change of alinement, and the character of the territory in which the line is located.

We have a great deal of territory in the South, in Louisiana, where it is very expensive to put in a concrete trestle, and at those places we are using creosoted trestles entirely. We figure that the cost runs about as stated here, $27 or $28, up to $40 or possibly $50 on very short bridges. If we only have three or four bents in the bridge the expense runs high. It costs considerably more to get the pile driver to do the work and go from one place to another for these small jobs. If the bridge is several hundred feet long, that expense is not so much for each bridge, relatively.

The President: Is there any further discussion? If not, we will put the question on the adoption of conclusion No. 6. Those in favor of the conclusion say aye; opposed no. The noes have it.

Mr. Safford: I move that Conclusion No. 7 be adopted.

(Motion seconded and carried.)

Mr. Frink: The next is No. 6, "Merits of Galvanized Iron Fastenings for Timber Trestles as Compared with Plain Iron and Steel Fastenings, especially in relation to their use on Creosoted Structures."

(Mr. Frink then read Conclusions 8 to 12 inclusive, which upon motion were adopted, for printing in the manual.)

The President: The committee will be dismissed with the thanks of the Association.

Report of the Committee on Rail

FOLLOWING the adoption by the American Railway Engineering Association of the rail designs recommended by this committee in 1915, the committee received a letter from the Manufacturers' Rail Committee criticising said designs on the grounds that certain principles embodied—namely, that of treating the rail as a girder, and of securing the highest ratio of section modulus to area of section—lead to an increase of failure of such rails in detail; also stating that they prefer designs which will give greater strength to resist types of failures which are prevalent.

John D. Isaacs, Chairman

The committee replied that it had given careful consideration to the manufacturers' criticism with every desire to find common ground for agreement as to standard sections, but that it was unable to determine from its experience that the criticism of the manufacturers is justified, and asked for definite statistics in support of their contention. The committee also stated its belief, based on experience, that, so far as failures are concerned, there can be no marked difference in results obtained ffom the manufacturers' and A. R. E. A. sections, but that the advantage of the latter, in their greater strength and in the possible strengthening of the joint bars (the weakest part of the track), is marked.

Under date of November 17, 1916, the Manufacturers' Rail Committee replied, reiterating the statements made in their original letter without substantiation. At our meeting on December 13, this matter was assigned to a sub-committee with instructions that it endeavor to obtain from the manufacturers their supporting data. Such data has not as yet been received. The committee, therefore, reports that investigations made by it have disclosed no good reasons for making any changes in rail designs already adopted.

The committee recommends that the following changes be made in the Specifications for Quenched Carbon and Quenched Alloy Steel Joint Bars appearing as Appendix A to the report of the committee on Rail, in the proceedings for 1916:

"Physical Properties and Tests

7. (b) Elastic Limit lbs. per sq. in., minimum—70,000-85,000.

"(c) The elastic limit shall be determined by the use of the Berry strain gage, or similar instrument, and

will be the load when the elongation shows a change in rate of stretch, the machine being operated at not more than ¼ in. per minute. After the elastic limit is reached the speed shall not exceed 2 in. per minute."

Rail Failure Statistics and Conclusions

The statistics covering rail failures for the period ending October 31, 1915, were issued in Bulletin 188 for August, 1916. The basis of comparison used has been changed from "Failures per 10,000 tons of rail laid" to "Failures per 100 track miles of rail laid."

The average failures per 100 track miles of the rollings for the several years, including both the Bessemer and Open-Hearth rails, are given in the following table:

Year Rolled	*Years' Service*					
	0	1	2	3	4	5
1908.....	...	....	....	.....	.....	398.1
1909.....	...	....	....	.....	224.1	277.8
1910.....	...	....	....	124.0	152.7	198.5
1911.....	...	....	77.0	104.4	133.3	.....
1912.....	...	28.9	43.1	49.3	.....	.....
1913.....	2.0	12.5	25.8	.....	.....	.....
1914.....	1.2	8.2	....	.....	.....	.....
1915.....	0.7	....	....	.....	.....	.....

It will be noted that the 1908, 1909 and 1910 rollings show successively decreased numbers of failures compared on a basis of five years' service and the later rollings also show successive reduction in failures when compared on a less number of years' service. A study of the results shows this to be due partly to the gradual replacement of Bessemer by open-hearth rails, and partly to improvement in both.

Special Investigation of Rails

During the year special reports have been presented to the rail committee as follows:

No. 55.—Transverse Fissure Rail, 51051, by M. H. Wickhorst.

No. 56.—Rail Failure Statistics for 1915, by M. H. Wickhorst.

No. 57.—Segregated Streaks in Steel Rail, by G. F. Comstock.

No. 58.—Test of Rail Joints, by H. B. MacFarland.

No. 59.—Induced Interior Transverse Fissures in Heads of Two Types, by Dr. P. H. Dudley.

No. 60.—Improvement in Method of Casting Ingots, by W. C. Cushing.

No. 61.—Rail Tests. Quick Bend Method. Pennsylvania Railroad. Report furnished by A. W. Gibbs and presented by W. C. Cushing.

No. 62.—Some Transverse Fissure Rails on the Louisville & Nashville Railroad, by M. H. Wickhorst.

No. 63.—The Rail Failure Situation, by M. H. Wickhorst.

The report on Transverse Fissure Rail, 51051, describes tests made on a 100-lb. P. S. Section, 1911 Carnegie O. H. rail, which failed from this cause in 1915. Results disclosed freedom from segregation, low ductility in interior of head and a number of longitudinal cracks in interior of head, which were disclosed by the etching and polishing.

The paper on Segregated Streaks in Steel Rails presents a review of various methods of etching and gives the author's opinion as to their relative value in detection of segregated streaks.

The paper on Tests of Rail Joints gives a study of the effects on the strength and rigidity of rail joints resulting from various percentages of carbon in untreated and in quenched angle bars, also as affected by the use of oil quenched minimum carbon versus untreated low carbon steel track bolts. The tests indicate that the strength of the metal varies with the carbon content when other elements are constant and the metal is handled in the same manner for both the heat treatment and quenching. Also, that proper quenching of the metal raises both the yield point and the ultimate strength of the steel and that the strength and rigidity of the joint is greater with oil quenched minimum carbon than with untreated low carbon steel bolts.

The paper on Induced Interior Transverse Fissures in Heads of Two Types gives the results of the author's extended experiments in this field. From his investigations Dr. Dudley concludes that induced interior transverse fissures in basic open-hearth rails are due in part to an occasional hot rail being rolled so cold or so rapidly cooled during manufacture before recalescence on the hotbeds as to cause a lag of some of the transformations of the metal in the interior of the head, which exceptional conditions of manufacture can be avoided. Such delayed transformations produce initial strains and a physical non-ductile core of heterogeneous metal near the center of the head. Mechanical injury to such metal by the gag produces an interior invisible fracture, which, when the rail is subjected to normal service, develops by detail growth until the section ruptures. Dr. Dudley classifies interior transverse fissures into two general types, Intergranular and Coalescent, resulting from gagging on the base or head.

Mr. Cushing's paper on Improvement in Method of Casting Ingots points out that the success which has been brought about in reduction of the number of rail failures annually has been due principally to the increase in weight, strength and stiffness of rail sections, improvement in specifications and by more rigid inspection. These changes have not brought about, except to a minor extent, an improvement in the quality of the material accepted for use. There is included an extract from an article entitled Some Properties of Ingots, by A. W. & H. Brearley, in The Engineer, describing the advantages of using a taper in the ingot mold with the wide end upward in eliminating the so-called secondary pipe.

The paper on Rail Tests, Quick Bend Method, gives the results of an investigation authorized by the Rail committee of the Pennsylvania System on April 9, 1915. The tests were conducted by the Pennsylvania at Altoona, Pa. The object of the investigation was to develop a substitute for the present drop test for rails, which it was found did not appear to give consistent results, in that the deflection and blows required to break the heavier rails now coming into use did not correspond with those which would normally be expected from the same height and weight of tup with an increased span. Preliminary tests made by the Illinois Steel Company in a Riehle testing machine are described, in which sections of rails were subjected to successive increments of loading. The calculated relationship of any one net elongation to the corresponding permanent set was found to check very closely with the corresponding data obtained from quick bend tests. The paper describes in detail a further development of this test method and includes results of comparative tests made by the Pennsylvania Railroad on rails of widely different physical and chemical properties by both the drop test and quick bend test methods.

The quick bend tests were made in a hydraulic forging press equipped to permit the taking of indicator cards of the pressures and corresponding deflections. The quick bend tests gave more consistent results than the drop tests. The principal advantages of the quick bend test are that data regarding the elasticity of the steel is obtainable and it is possible to more definitely determine the ductility since a more detailed study can be made of the relation existing between the deflections

and loads at points between the elastic limit load and the ultimate load. On the other hand, it is probably not as good a test for brittleness as the drop test. This committee, in conjunction with the Manufacturers' Rail Committee, has under consideration the quick bend test as a substitute for the drop test for rails.

The paper on transverse fissure rails on the Louisville & Nashville gives the results of the examination of 11 rails which broke on that road, showing transverse fissures. The general result was that chemically the rails showed a tendency toward hardness, but were free from considerable segregation. Physically the rails showed good properties except in the interior of the head, where the metal contained numerous small cracks and was of low ductility.

The paper on the Rail Failure Situation gives a general discussions of the different types of rail failures, their causes and the remedies to be applied to overcome the failures. It presents the conclusions that may be drawn at the present time from the investigations we have been making in the last few years.

Committee: J. D. Isaacs (S. P.), chairman; R. Montfort (L. & N.), vice-chairman; E. B. Ashby (L. V.), E. E. Adams (U. P.), J. A. Atwood (P. & L. E.), A. S. Baldwin (I. C.), W. C. Barnes (S. P.), J. B. Berry (Cons. Engr.), C. S. Churchill (N. & W.), W. C. Cushing (P. L. W.), G. M. Davidson (C. & N. W.), Dr. P. H. Dudley (N. Y. C.), J. M. R. Fairbairn (C. P.), C. F. W. Felt (A. T. & S. F.), L. C. Fritch (C. N.), A. W. Gibbs (P. R. R.), H. G. Kelley (G. T.), C. F. Loweth (C. M. & St. P.), H. B. MacFarland (A. T. & S. F.), C. A. Morse (C. R. I. & P.), J. R. Onderdonk (B. & O.), G. J. Ray (D. L. & W.), H. R. Safford (G. T.), J. P. Snow (Cons Engr.), F. S. Stevens (P. & R.), E. Stimson (B. & O.), R. Trimble (P. L. W.), G. W. Vaughan (N. Y. C.), M. H. Wickhorst.

The Rail Failure Situation. By M. H. Wickhorst, Engineer of Tests, Rail Committee

From the standpoint of the visible condition of the failed rails, most of the rail failures may be divided into four classes, as follows:

(1) Crushed and split heads.
(2) Internal fissures (transverse and horizontal).
(3) Broken bases (crescent breaks).
(4) Broken rails (square and angular breaks).

Crushed and Split Heads

Head failures are the most numerous, and most of these may be described as crushed or split heads. This failure consists of an internal vertical crack in the head running lengthwise of the rail anywhere from a foot or two to several yards in length. The external appearance may show only a crushing of the head; but, when broken, the rail will show a vertical or obliquely vertical crack in the interior of the head running lengthwise of the rail. This kind of failure is confined mostly to metal showing considerable interior segregation of carbon, phosphorus and sulphur, attended more or less with laminations, streaks and slag seams. Usually, also, along with this interior condition there is a softness of the outer portions of the rail section, including the top of the head. The "peaning" or "ironing" action of the rolling wheels causes a side spread of the top part of the head. The outer metal has practically always sufficient ductility to stand this side spread, but if the interior metal has not, it develops a crack, which keeps growing until a split head results. The crack generally comes to the surface at the under side of the head at its junction with the web, but sometimes it extends downward into the web and comes to the surface at the side of the web. Abstractly stated, split heads may be said to be due to a lack of transverse ductility in the interior of the head.

Internal Fissures

Strictly speaking, a split head is a case of internal fissure, but this latter term is usually applied to a type of failure that has become prominent in recent years while the split head is an old type and was long known as "piped" rail. Internal fissures may be divided into three groups, as follows:

(1) Simple transverse fissure.
(2) Simple horizontal fissure.
(3) Compound fissure.

The simple transverse fissure is probably the most numerous. This type of failure first came prominently to public attention in Mr. Howard's report on the Manchester wreck on the Lehigh Valley that occurred August 25, 1911. A characteristic and constant feature of the transverse fissure is the "nucleus," a granular or crystalline spot surrounded by the smooth or polished part of the fissure. The nucleus is ordinarily from ⅛ to ¼ in. in diameter, but may be larger or smaller. The surrounding smooth part has been found in all sizes from nothing to almost the full size of the head. It seems fairly certain that the nucleus acted as a center of growth from which the fissure developed under repeated "alternations of stress" or the "wave action" under moving trains, but the origin of the nucleus seems not yet to have been fully explained, although undoubtedly, a vital part of the problem.

The simple horizontal fissure seems not to be frequent in rails that have broken in track, as before the point of breakage is reached a transverse crack branches off from the horizontal one, finally breaking as a compound fissure. The compound fissure, or as Dr. P. H. Dudley has called it, the coalescent type, consists of both horizontal and transverse parts, and seems to be a development of the horizontal fissure. A noticeable feature of these two types of fissure is the presence of a longitudinal streak or lamination that acted as a center of growth from which the horizontal part of the fissure developed. After a while a branch starts up or down from the horizontal crack and after it has attained sufficient size a break occurs as a compound fissure.

To give a full and satisfactory explanation of the cause or causes of internal fissures has proved a very baffling problem, but the fog seems to be lifting slightly and we may now dimly discern some of the important matters involved in the production of fissures. When examined chemically, fissured rails have shown a tendency toward hardness. The carbon is generally above 0.70 per cent and frequently above 0.75 or 0.80 per cent. The rails with compound fissures seem generally to show interior segregation of carbon, phosphorus and sulphur, but those with simple transverse fissures have usually shown a fairly even distribution of the elements, as determined by a comparison of samples from the corner and the interior of the head.

When examined physically the rails have generally shown good physical properties in the different parts of the rail section, except in the interior of the head, where the ductility has usually been low and frequently entirely absent. When examined for small cracks by a process of etching and highly polishing, fissured rails have also shown numerous small cracks in the interior of the head; that is, the metal inside the head was in a generally torn condition. The investigations have not, however, as yet shown to what extent this was an original condition of the rail as made, and to what extent it developed in service.

The early work on rails with fissures seemed to indicate that such rails came indiscriminately from all parts of the ingot, but more recent investigations now idicate that fissures occur mostly in rails from the upper part of the ingot, and particularly in the B rails. For instance this is shown in a tabulation given below, made by the New York State Commission, of fissured rails reported to it:

Rail Letter	No. of Failures
A	69
B	137
C	67
D	41
E	36
	350

The tabulation presumably covers rails with compound fissures as well as simple transverse fissures, although probably a distinction should be made. In an unpublished investigation of a whole heat in which several failures occurred in the track, due to transverse fissures, and in which all the rails were afterward broken in the gag press, showing a considerable number of simple transverse fissures, the writer found a preponderance of the fissures occurring in the B rails, and no fissures were found in the lower third of the ingot.

From the above discussion it is thus beginning to appear that split heads, transverse fissures and compound fissures are related and perhaps simply different manifestations of what is fundamentally the same trouble. Split heads occur mostly in the top rail of the ingot in segregated steel and this seems to be true also of compound fissures, although considerably more evidence is needed on this latter point. It also seems that transverse fissures are most numerous in rails from the upper part of the ingot, but when examined by the usual chemical methods they are generally free from much segregation, and instead of being most numerous in the top rail they seem to occur mostly in the second or B rail. These types of failure are the results of growth under repeated strains and the age of the rail at the time of failure would be a function of the wheel loads and the number of wheels passing over the rail, as well as of the rail section and the interior condition of the rail. If the rail is too light for the service or the track is improperly maintained, the rail will become battered at the ends and become distorted and unridable for fast service, but with sound metal in the interior of the head it is not apt to develop a split head or fissure.

Broken Bases

The broken base occurs as a half-moon or crescent-shaped piece broken out of the flange. These occur mostly at ties and are largely attended with seams in the base. They seem to be more numerous in light, thin flange rails than in the more recent sections, which have thicker flanges and are also usually heavier when a change of section is adopted.

Broken Rails

The term "broken" rail is applied to a rail which is broken through the whole section without showing an apparent interior defect, the square break being approximately vertical through the section and the angular break occurring obliquely through the section. This type of failure, as well as the broken base type, is most predominant in winter, particularly in severely cold weather, and may be termed "winter disease" of rails. The severe winter of 1911 and 1912 brought out a very abundant crop of such failures on the northern roads. An examination of the fractures of such rails shows that the fracture is upward through the section; that is, it starts from the base, and the rails also show longitudinal cracks or seams at the bottom of the base. H. B. MacFarland, Engineer of Tests, Atchison, Topeka & Santa Fe, made an interesting report in which he showed that most "broken" rails were accompanied by half-moon base fractures, which observation has also resulted from other investigations. Probably the most prominent feature of the appearance of most "broken" rails is what may be called the "scalloped" fracture across the bottom of the base; that is, the fracture is not straight across the base, but one side is concave or re-entrant with a sharp corner, while the other side is pointed and dovetails into it. The concave side of the fracture also generally shows a seam in the bottom of the base.

In both the broken base and the broken rail the break starts in a longitudinal seam in the bottom of the base. If the seam is off to one side of the center, not under the web, a piece of the flange breaks out and the failure is a broken base; but if the seam is about central and under the web, a piece of the flange starts to break out, but the break continues upward through the whole section and the failure is a "broken" rail.

Seams in the Base of Rails

Rails frequently contain longitudinal surface seams, and in this connection a study of the behavior in the drop test of a rail containing seams in the bottom of the base is important. These base seams vary in depth from 0.01 in. to 0.1 in., and are occasionally deeper.

When tested in the drop test in the usual manner, the rail ordinarily breaks at or near the place where hit by the trip, due to the exhaustion of the longitudinal ductility of the part in tension. Occasionally, however, when tested with the base in tension (that is, with the base resting on the supports), the fracture occurs near one of the supports. This was a 100-lb. rail broken in the drop test with the base in tension, supports 3 ft. apart, and given one blow of a 2,000-lb. tup from a height of 20 ft. The impression left on the base by the support was chalked to show up more clearly in the illustration, and it will be noted that the permanent impression was confined mostly to the middle third of the width of the base. It will be noted that the pressure of the rail on the support caused some side spread of the base at this place, which in turn opened up a seam. A piece of the flange broke and a fracture occurred through the whole section 3½ in. from the support as a secondary break. The failure of this rail occurred long before the longitudinal ductility was exhausted, and may be considered as due to insufficient transverse ductility at the bottom of the base because of the presence of seams.

When tested with the head in tension, the result is of a similar nature if there is a seam in the base at the place where struck by the tup. Here again, the blow of the tup caused a side spread of the metal of the base where struck, which in turn opened up a seam, causing a failure from the top side, not due to the exhaustion of the longitudinal ductility of the head.

Remedies

From the above discussion it may be gathered that there are two general causes for rail failures, so far as the rail itself is concerned, as follows:

1. A defective condition of the interior of the upper part of the ingot, such as segregation of carbon, phosphorus and sulphur, blowholes and slag, causing split heads and fissures.
2. Seams in the bottom of the base, causing broken bases and broken rails.

Efforts to improve the rail must, therefore, in gen-

eral, take two different directions, one to improve the top part of the ingot or not to use it for rails, and the other to avoid having seams in the bottom of the base.

As made in the usual iron mold, with the small, open end on top, the ordinary steel ingot is spongy in the upper end with more or less interior segregation and a central cavity, called a pipe. The use of sufficient silicon, titanium or aluminum reduces the spongy condition and the segregation, but the size of the pipe is then increased and it also extends farther down into the ingot. The minimum amounts of these deoxidizers required for their full influence are about as follows: Silicon, 0.25 per cent; titanium, 0.01 per cent, when added in the form of ferro-titanium; and aluminum, 0.005 per cent. Steel with insufficient deoxidizer is "lively" in the mold and the ingot sets with a raised or "horny" top, and as such a top is indicative of considerable interior segregation, strong efforts should be made to avoid using ingots with raised tops for rails.

The service required of the rail has continuously grown more severe since the time that railroads were first built, and the time has probably arrived when the upper 25 or 30 per cent of the ingot as ordinarily made can no longer be considered suitable for rails intended for heavy service.

Two courses seem to be open, as follows:

1. Make the ingots in the ordinary manner and cut off from the top end of the bloom the equivalent of 25 or 30 per cent of the weight of the ingot, or, in other words, make a top discard of 25 or 30 per cent. This top part may then be used for other purposes, or it may be remelted.

2. Make the ingots by some form of "hot top" process in which the top of the ingot is kept liquid, to feed to the shrinkage space that would otherwise form a pipe. With such a process the harmful segregation can be kept in the upper 10 per cent of the ingot and full advantage can be taken of the benefits of quiet setting steel effectively deoxidized.

Which procedure is best will depend on the local conditions of the steel plant and the kinds of other products made. The cost of making the rails would of course be least by using the ordinary ingot and using the lower part for rails and the upper part for other product. This is largely the practice at one mill, but other mills may find it best to remelt the bloom butts, or to use the hot-top process of making ingots. This latter process has so far been used only in a small way for rails, but it seems probable that in the future it will be worked out in a practicable way for rail manufacture on a large scale.

It has sometimes been stated that rails break because they are too light, and that therefore their weight should be increased, including the weight of the head. There is, of course, an advantage in heavy rail as regards smooth riding track and ease of maintenance, but the weight of the rail can be considered only a minor factor as regards head failures. The primary cause of head failures must be considered to be a defective internal condition. This would not be bettered by an increase of weight, nor would the strength of the rail to resist head failure be materially increased by an increase in the weight of the head. As regards base failures and "broken" rails, the situation is somewhat different, and this will be referred to later.

A further development is also needed in our rail specifications. The drop test is primarily a test for ductility and should be used to safeguard as far as possible the ductility of the metal in the interior of the head. For this reason the rail should be tested in the drop test, with the head down, so as to get this part in tension and to more effectively detect excessive interior segregation than when tested with the base down. The ductility is measured by putting prick punch marks one inch apart on the part in tension and then measuring the elongation of the one-inch spaces after test. We now require a minimum elongation of 6 per cent, which means a stretch in the interior of the head of about 4 per cent. Metal which can stretch only this amount cannot be considered satisfactory for heavy-duty rail, and our elongation requirement should be increased to at least 8 per cent, and probably to 10 per sent. Another refinement that we may wish to consider is the removal for a short distance of the top part of the head, so as to get the interior metal of the head at the place where the fibers are stretched most in the drop test, as was suggested by Fremont, in France, several years ago.

We now come to the other general cause of rail failures, namely, seams in the bottom of the base. Roughly, about half the rail failures are traceable to the interior condition of the ingot and the other half, or most of them, are traceable to base seams. (I am not now, however, from the present standpoint, considering as rail failures those rails distorted out of shape on account of service conditions, as, for instance, rails battered at the ends, due to loose and improperly maintained joints.) The deep seams probably originate mostly from tears in rolling the ingot into the bloom, starting in turn from cracks in the surface of the ingot, but we are very lacking in definite information as to the exact influence of the several conditions that may affect the rolling, such as the condition of the mold, the temperature of the ingot, the method of heating the soaking pits, the amount of draft in making the bloom, the forms of the shaping passes, etc.

With the older thin-base sections a seam in the bottom of the base is specially harmful, and probably the chief merit of the thick bases of such sections as the A. R. A. sections, is the increased strength of the base to resist failure by the opening up of a seam, although originally designed to provide more uniform finishing temperature throughout the section. More recently, also, the fillet between the web and the base has been increased in some rail sections to afford additional strength against broken rails. From the manufacturing standpoint, the Lackawanna Steel Company several years ago devised a deseamer, a machine for milling the surface from the hot bar before fully formed into rail, thereby removing most of the defects from the bottom of the base of the rail.

Besides the elimination of seams, we also have the problem of increasing the transverse ductility of the base, which is generally both low and irregular. When a rail is supported near the edges of its flanges and loaded on top so as to stretch the bottom of the base crosswise, it generally stretches only about 1 per cent or less before breaking, and only occasionally does a sample give an elongation over 3 or 4 per cent. Research should be directed toward regularly producing rails that will give a ductility of not less than, say, 4 or 5 per cent transverse stretch at the bottom of the base. We also need some kind of a proof test to which each rail could be subjected for the purpose of eliminating the rails which contain dangerous seams in the bottom of the base.

Having obtained a sound rail, free from defects, it behooves the railroad to maintain the track and joints in a careful manner in order to obtain the best results from the rail. Bad track conditions or poor maintenance are not apt to result in a rail failure with an otherwise good rail, but they will result in battered ends and a poor riding track which will require premature

renewal of the rail, or at least sawing off the bad ends. A heavy rail with a thick base or large fillets between the web and the base is desirable to guard against broken bases and "broken" rails, but probably would not have much effect toward reducing head failures.

Conclusion

It is sometimes stated that rails are being made as well as they can be, commercially, and that perfection is not possible or to be expected. From the standpoint of rail failures, perfection would be a condition where rails are removed from service only because they are worn out, and where a rail is never taken out of track because it is broken. While we may not be able to fully attain this condition, still it is probably commercially practicable to reduce the number and kind of rail failures to a point where the probability of accident from a broken rail will be almost nothing, and where we may remove "failed rail" from our classifications of causes of accident.

Discussion

J. D. Isaacs, chairman of the committee, being absent, R. Montfort (L. & N.), vice-chairman, presented the report.

Mr. Montfort: It is greatly to be regretted that Mr. Isaacs is unable to attend the meeting. He is the author of this report. The president calls attention to the fact that the manual does not contain the specifications for joint bars.

H. B. MacFarland (A. T. & S. F.): If the specification is not contained in the manual, the proper thing to do would be to move that the change be incorporated in the tentative specifications adopted last year and shown in Appendix A, page 448.

The President: Those specifications were not adopted, but were held over for presentation this year. Is it your purpose to present these specifications for adoption this year?

Mr. MacFarland: I believe it is better to hold them over for another year and receive this insertion for incorporation next year in the manual.

The President: Then it is in the province of the committee to submit this when it submits the specifications for approval. In the meantime this change in this clause 7 relating to elastic limit will be inserted in the proceedings. It is understood that these specifications have not been submitted for approval, and have not been approved by the Association.

Mr. Montfort: Mr. Wickhorst has some remarks to make, I think.

M. H. Wickhorst (Eng. of Tests, Rail Com.): I simply want to make a report of progress for the subcommittee, of which Mr. Onderdonk is chairman. That committee has outlined a series of experiments on the reciprocating or rolling machine at Sparrows Point, in which a rail can be given any desired load and the load rolled back and forth over the rail. This is presented in tentative form. The committee has some work under way.

The President: We will now hear from Mr. Wickhorst on rail failure statistics, illustrated by lantern slides.

(This paper is abstracted above.)

(The committee was dismissed, with the thanks of the Association.)

Report on Conservation of Natural Resources

THE committee made an extended investigation of logging methods and of the extent to which waste forest materials are being utilized. Attention was called to recent developments whereby the materials formerly wasted are now being used to make paper, veneer, excelsior and chemicals. It is estimated that in addition to the refuse used for fuel under boilers, there is a waste of 36,000,000 cords of wood anually. The committee also called attention to the fuel economy campaigns which are being conducted on a number of roads and to the use of pulverized coal as a means of conserving the natural resources.

R. C. Young, Chairman

One section of the report was devoted to statistics showing the increase in the use of treated timber in the United States and Canada. While the preservative treatment of timbers is still in its infancy on this continent, much more progress has been made in the United States, where, in the East, the pinch of partial exhaustion of timber supplies is being felt, than in Canada, where supplies are still relatively large in proportion to the population. In the United States the number of wood-preserving plants has increased in ten years from 39 to over 100. In 1915, at 102 plants, nearly 142,000,000 cu. ft. of timber was given preservation treatment. Of this more than 78 per cent was cross ties, for railway use.

Preservative treatment of ties makes it possible in the East to utilize so-called inferior species, such as beech, birch and maple, in place of the now relatively scarce and much more expensive oak and cedar, which were formerly used to a very large extent. In this way better service is secured at a materially lower cost.

The slower developments along this line in Canada are due to the fact that we still have large supplies of coniferous material suitable for ties. For instance, in 1914 more than 43 per cent of all ties purchased in Canada were jack pine. Eastern cedar followed next with 13.7 per cent, then tamarack with 7.8 per cent, Douglas fir with 7.5 per cent, and hemlock with 7.2 per cent. Canadian railways require about 20,000,000 ties per year.

At the present time there are six commercial treating plants in Canada, all of which have been built since 1910. The Forest Products Laboratories of the Forestry Branch of the Department of the Interior possesses an experimental plant in which railway ties, paving blocks and other timber can be treated, and which is furnished with the necessary equipment for the impregnation of wood by the various commercial processes. These laboratories are devoting considerable attention to the preservative treatment of railway ties, wood paving blocks and fence posts, as well as to the study of the causes and prevention of dry rot in factory and other buildings.

As a means of conserving human life it is recommended that laws be enacted making trespassing upon railroad tracks a misdemeanor, to prevent accidents and consequent damage claims resulting therefrom.

Committee: R. C. Young (L. S. & I.), chairman; S. N. Williams, vice-chairman; R. H. Aishton (C. & N.

W.), C. B. Brown (Intercolonial), Moses Burpee (B. & Ar.), E. B. Cushing (S. P.), A. L. Davis (I. C.), C. H. Fisk (Cons. Engr.), W. P. Kellett (L. E. & N.), William McNab (G. T.), A. L. Moorshead (Erie), Francis Lee Stuart (Cons. Engr.).

Discussion

R. C. Young (L. S. & I. and M. M. & S.): This report is one of information. This seems necessary because these different subjects can be best considered by a campaign of publicity and education. I am not going to take up any time in calling your attention to the different features of the report, except to state that the saving result in the method of lumbering is noted in subject No. 2, also in the accomplishment of another purpose, and that is the cleaning up of the land and rubbish marketing. Valuable timbering and preserving of the land from forest fires, which is absolutely necessary in order to accomplish any reforestation, seems necessary. I want to call attention to the work being done by the Forest Protective Association and the state forest departments in connection with the railroad companies. Also, in view of the impending meeting with the Committee on Electricity, it was thought best to omit from the public reports that part referring to electrification of railroads. That will be taken up by this committee or by the Committee on Electricity. I have a letter from A. W. Carpenter, of New York Central Lines, referring to discussions that occurred last year that seems to be in line with the results of the committee's report.

A. W. Carpenter (N. Y. C.) presented a discussion by letter referring to statements made in discussion last year on this committee's report. He took exception to references to tree planting efforts as dismal failures, pointing out the experience of the Pennsylvania and the Delaware & Hudson in work of this kind.

Mr. McNab: I move the adoption of this report, with the exception of that part referring to electrification of railways, and that that be held over and not printed in the proceedings, pending investigation.

(Motion seconded and carried.)

Report of Committee on Stresses in Railroad Track

THE special committee on Stresses in Track, co-operating with a similar committee of the American Society of Civil Engineers, presents the following report of progress:

From the beginning the committee has felt that its work must be based upon adequate experimental data derived from tests on standard railroad track, and it has also appreciated that because of the complexity of the action of railroad track under load adequate experimental work would of necessity involve long, painstaking and repeated tests and sufficient time for reducing the data so obtained. Experience has shown that the anticipated difficulties were not overestimated. The committee feels that the experimental work has made encouraging progress during the past year. In this time the instruments used have been further developed; especially has the stremmatograph (the instrument for measuring strains in the rail under rapidly-moving loads and for giving a continuous record of the action of the rail under and between the wheel loads of the moving locomotive) been the subject of further improvement, and new instruments have been made for larger rail sizes. Tests with the stremmatograph have also been made to find the usefulness of this instrument in determining the action of rails on curves, resulting in a considerable promise of success.

A. N. Talbot, Chairman

During 1916, field tests conducted on the main line of the Illinois Central north of Champaign, Illinois, have been made on rails of 85-lb., 125-lb. and 136-lb. sections with the Mikado, the Pacific and the Atlantic types of locomotives running at various speeds, and results previously obtained have been checked and the gaps filled out. Tests have also been made on track with cinder ballast.

During the fall the test party was engaged in test work on the track of the Delaware, Lackawanna & Western near Dover, New Jersey. Tests were made with four types of locomotives, run at various speeds over track laid with 105-lb. rail. In addition to the strains in the rail, track depressions were measured. Static tests were made to determine bending in ties and stresses in track. A few tests were made on curves. The data of these tests are now being wosked up.

Laboratory tests on the distribution of pressure downward through ballast material have been carried on. Apparatus has been installed and tests made with stone ballast, gravel ballast and sand, using different depths of material and loads up to 50,000 lb. These tests are to be continued, and it is expected that the data will be of service in establishing laws on the distribution of pressure downward and laterally through ballast and other granular material.

The work of reducing all test data has been carried on during the year, and while this part of the work has consumed a large amount of time, the material is being put into satisfactory form for final record.

The committee had expected before this to be able to report the data already obtained, but the work of studying and formulating the results of the experimental work has been time-consuming. A disability of the chairman has further delayed the progress of the presentation of the data. However, the committee is able to report progress in making up the report of the tests.

Committee: A. N. Talbot (Univ. of Ill.), chairman; W. M. Dawley (Erie), vice-chairman; A. S. Baldwin (I. C.), J. B. Berry (Cons. Engr.), G. H. Bremner (I. C. C.), John Brunner (Ill. Steel Co.), W. J. Burton (M. P.), Chas. S. Churchill (N. & W.), W. C. Cushing (P. L. W.), Dr. P. H. Dudley (N. Y. C.), H. E. Hale (Pres. Conf. Com. on Val.), Robt. W. Hunt (R. W. Hunt & Co.), J. B. Jenkins (B. & O.), George W. Kittredge (N. Y. C.), P. M. LaBach (C. R. I. & P.), C. G. E. Larsson (Am. Br. Co.), G. J. Ray (D. L. & W.), Albert Reichmann (Am. Br. Co.), H. R. Safford (G. T.), Earl Stimson (B. & O.), F. E. Turneaure (Univ. of Wis.), J. E. Willoughby (A. C. L.).

Discussion

Prof. Talbot: It may be of interest to note two or three matters which seem to come out as the result of

these tests. The first is in regard to the general question of the effect of spacing of ties. The statement is sometimes put forward that the rail forms little bridges from tie to tie. I think we ought to put that the other way: that the distance from driver to driver forms the span of the bridge, the driver loads being the reaction, while the upward pressure from the ties represents the loads. I judge that changing the tie spacing, shortening the tie spacing 25 per cent, would not make more than 25 per cent difference in the bending moment developed in the rail. Another thing referred to last year in the remarks of the Chairman bears out the fact that the heavier the rail the greater the magnitude to the bending moment developed for a given wheel load. The laboratory tests of distribution of pressure laterally between wood, through ballast, has given some interesting results. It appears that under the tie the pressures are not distributed very uniformly over the width of the tie. Near the edges the pressure is very light and the lateral distribution, as we go downward below the tie, does not amount to very much when we get as far down as 10 or 12 in. below the bottom of the tie. However, the results we have show that when we get to a depth of 18 or 20 in. the pressures begin to become rather uniform in a direction parallel to the track.

The President: Does anyone wish to ask any questions of Prof. Talbot? If not, the committee will be dismissed with the thanks of the association.

PUNCHED OUT TRACK SIGNS

By J. W. Orrock

Principal Assistant Engineer, Canadian Pacific

Track signs in general are considered more of an eyesore than an ornament on the right-of-way, and the tendency on the Canadian Pacific Railway is to limit their use and to make those that are necessary as inconspicuous as possible without losing any of the main features for which the signs are erected.

The desire also to get away from the everlasting painting of signs has led to a number of devices such as concrete signs with the letters made in a black mixture, the cast-iron sign with the letters cast on them and the punched-out sign where the letters or figures are punched out and daylight takes the place of paint.

On some roads the signs are painted twice a year (in April and October) by a painting gang, which may be accommodated in a boarding car or train; other roads paint their signs once a year, and in a great many cases only once every two or three years.

If it were possible, therefore, to dispense with the painting of letters or numbers on signs and it were simply a matter of straight painting, a large part of the paint gangs' work would be cut out, as it could be done by the section men with considerable economy. The object of the punched-out sign as adopted by the Canadian Pacific is an attempt to arrive at this result.

These signs have been introduced so far for bridge numbers, snow plow and flanger posts, whistle posts, section numbers, mile and culvert numbers; when erected they are very inconspicuous and to the ordinary layman are hardly noticeable; especially is this the case with bridge numbers, as the plate is painted the same color as the bridge (when the bridge is painted), they tend to blend into the structure although the salient feature of the sign stands out clear and sharp to employes.

The various signs may be briefly described as follows:

The wooden bridge sign used previous to the punched-out metal sign cost $1.25 in place and had to be painted every two or three years; in some districts wooden signs are painted every year; to paint this sign in black and white was estimated, with a painting gang on the road, to cost 75 cents per sign, for material and labor, for a term of three years. The punched-out sign, made of $\frac{3}{16}$-in. plate, now used in place of the wooden sign, costs 75 cents when furnished with a new bridge, and when replacing a wooden sign the cost is $1. There is practically no maintenance to this sign, as it is a part of the bridge and is painted when the bridge is painted; there is no lettering and the little paint required to cover it when the bridge is being painted is practically nothing.

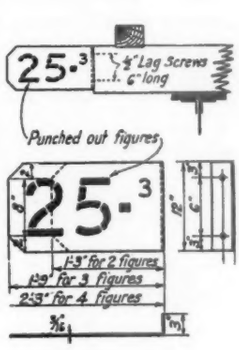

Fig.1. Bridge Number

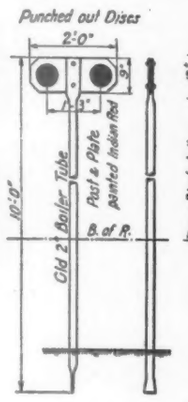

Fig.2. Snow Plow Post

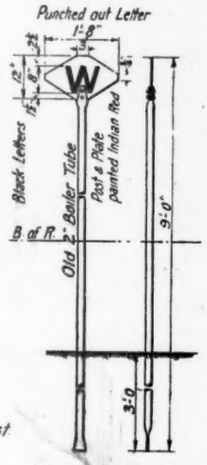

Fig.3. Whistle Post

It is figured that the punched-out metal bridge sign will outlast the wooden sign four to one; therefore, the saving from renewals and repainting is quite large; for example, if the wooden sign lasts 12 years, the metal sign will last 48 years; the saving during this period for a punched-out sign, figuring that the wood sign costs 75 cents for repainting every three years, would be $16. The saving of $16, or even half or quarter of this amount, on each bridge sign on a large system amounts to a very big sum, and when it is worked out for other signs, on the same basis, such as mile boards, snow plow signs, whistle posts, etc., the saving is bound to be considerable.

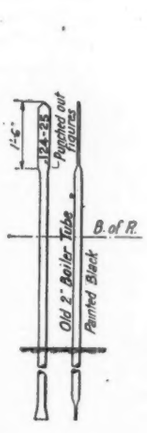

Fig.4 Culvert Number

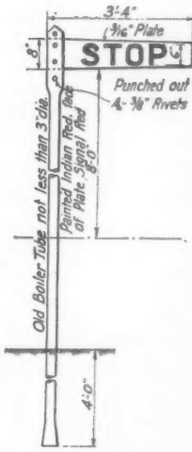

Fig.5. Stop Post

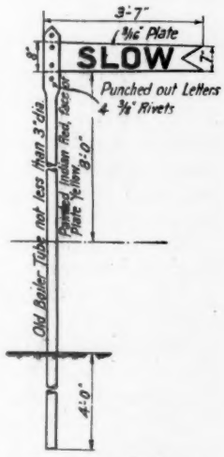

Fig.6. Slow Post

Snow plow and flanger post signs are used to indicate that wings, plow points or flange blades have to be brought to clear. On the Canadian Pacific they are placed 8 ft. from the rail at crossings; where planking is maintained in winter, and 150 ft. each way, on the

engineer's side of the track, from all bridges, tunnels, rock cuts, etc., where necessary to clear wings. At switches, public road crossings or stations, however, the switch stand, public road crossing sign, or station building indicates the obstruction, and snow plow signs are not considered necessary at such points.

The old wooden type of snow plow sign consisted of a 4 in. by 4 in. post with a 1 in. by 9 in. by 24 in. board on top. The board was painted black and the discs and post white. The discs were painted on both sides and cost $1.75. The new steel punched-out sign consists of an old 2-in. boiler tube post with a ⅛-in. plate on top. The post and plate are painted black and the discs are punched out; the cost is $1.25.

It may be mentioned that the punched-out discs are particularly good for this type of sign, as in winter they show up white against the black plate. Their economy consists in getting away from painted discs and the use of one color instead of two.

Whistle posts are erected on each side of and at a distance of about one-quarter mile from all public and

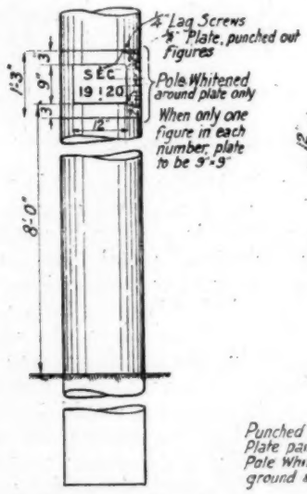

Fig. 7. Section Number.

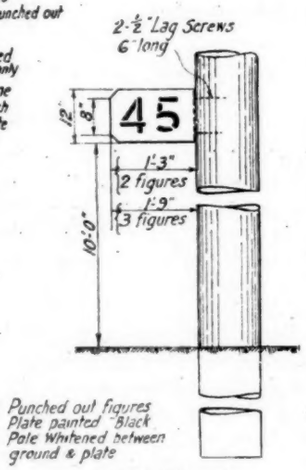

Fig. 8. Mile Number.

highway crossings at grade, blind curves and tunnels, 8 ft. from the rail on the engineer's side.

The old wooden whistle posts were made of 10 in. by 3 in. boards planed and dressed with the letter "W" painted black and the post white, and cost $1.50. The new punched-out sign consists of an old 2-in. boiler tube and ⅛-in. steel plate with the letter "W" punched out; cost, $1.25.

Section posts are used to mark the boundary of each section foreman's territory. The old post consisted of a 4 in. by 4 in. upright and 1 in. by 18 in. by 10 in. board placed 7 to 8 ft. from the rail; the letters were painted black and the pole white, and cost $1. The new sign consists of a punched-out plate, which is placed on the nearest telegraph pole. The pole behind the plate is painted white and the plate black, and costs 50 to 75 cents each.

On the Canadian Pacific Railway the mile board signs are placed on the nearest telegraph pole. The old type of wood board consists of a piece of plank 10 in. by 1½ in. by 3 ft. 3 in. long, on which was painted the mile and the plus in feet. The board was painted white and the letters black, and cost $1. The new metal sign is made of ⅛-in. plate with the mile number punched out. The plate is painted black and costs 50 to 75 cents, depending upon the number of figures.

Culvert number posts have been abandoned on the Canadian Pacific Railway. The old sign consisted of a wood post with the numbers painted at the top, or an old boiler tube was used, flattened at the top and painted the same as the wooden post; the posts were painted in black and white, and cost 75 cents. The punched-out sign consisted of an old boiler tube flattened at the top with the figures punched out, only black paint being used, and costs $1.

On the Canadian Pacific stop and slow post signs are placed on the engineer's side of the track 8 ft. from the rail and 400 ft. from all grade crossings, junctions, drawbridges, etc., not protected by interlocking where trains must come to a full stop, or 2,000 ft. at points for slow signs when trains must be under full control. The old wooden stop and slow signs were built with posts 6 in. by 6 in., with 1 in. thick blades bolted to the posts. The letters were painted in white on a red background for stop blades and black letters on a yellow background for slow blades, with the balance white, and cost $3 each. The new stop and slow signs are built of old boiler tubes, with $\frac{3}{16}$-in. metal blades. The letters are punched out, the stop blade is painted red, the slow blade yellow and the balance white. The signs cost $2.25 each.

ANNUAL MEETING OF THE N. R. A. A.

The annual meeting of the National Railway Appliances Association was held in the Coliseum at 11 a. m. on Tuesday, March 20. President H. M. Sperry, Bureau of Railway Signal Economics, was in the chair and carried the business of the meeting through very promptly. After the roll call and approval of the minutes of the last meeting, the president read his annual report, from which the following is abstracted:

"The ninth annual exhibition of the National Railway Appliances Association sets the same high standard as in previous years. This year we have a total of 170 members, of which 143 are exhibitors.

"Our exhibition opened exactly on schedule time, although our exhibitors for the first time had to face a freight congestion on our railways of extraordinary magnitude. Our exhibitors are to be congratulated on the effective way in which they met this situation. It shows what our American manufacturers can do when put to the test. Invitations to the exhibition were sent out to a selected list of 14,921 railway officers of both steam and electric roads, members of the American Railway Engineering Association and the Railway Signal Association. Also to the members of the Interstate Commerce Commission, the engineering staff of technical colleges and to leading railway contractors. One hundred thousand passes have been issued for distribution to our members and to the railways. The attendance on Monday was 3,442, as compared with 3,042 on the corresponding day last year.

"The treasurer's report shows that the Association finances are in a satisfactory condition. By the use of the 'budget system,' a careful estimate is made of receipts and expenditures, with the result that our balance is well on the right side of our books.

"The care that the board of directors has exercised in the management of the exhibition can be measured by the price charged for space, as compared with other exhibitions held in the Coliseum. The price charged by other exhibitions shows an average of one dollar per square foot. Our price ranges from 40 to 70 cents per square foot.

"This year 38 applications for space were received that could not be taken care of. The board has considered

other locations for an exhibition, and also the use of the balcony in the Coliseum. The most promising solution of the problem is to somewhat reduce the size of our larger exhibits in order to increase the number and variety of the exhibits. If this can be worked out so as to add to the value of the exhibition as a whole it may carry us through until a larger exhibition building is available.

"Our present constitution was found to be defective in a number of its provisions, therefore a complete revision was undertaken. The committee in charge of this revision will submit its report for your consideration.

"In closing seven years' service on the Board of Directors, permit me to point out two of the features that help make this exhibition a success.

"First, these exhibitions are splendid examples of what can be done through co-operation by firms engaged in the same industry.

"Second, these exhibitions have a high educational value, as they bring together exhibits of railway materials that are representative of the best practice. The educational value of the exhibition has been recognized this year by three of our railway papers uniting in conducting a contest for the best papers written by railway men descriptive of the exhibition as a whole. Cash prizes are offered for the best papers.

"We, as manufacturers of railway appliances, are a part of the great transportation industry of the country. If we are to plunge into war, then our transportation machine must be raised to the highest efficiency. Our railways must be placed in the strongest possible position. Our railways need larger earnings in order to expand their facilities and equipment. They need uniform laws and regulations in place of the confusing and conflicting laws and regulations of the various states and Federal Government.

"We, both as manufacturers and as citizens, are vitally interested in the successful operation of our railways. Let us do all in our power as an association and as citizens to place our transportation machine in condition to stand the strain that will be imposed upon it. We need to do this in the event of war, and there will be a greater need for efficient transportation service when peace again brings us into competition with the nations of the world. Our exhibition shows what we can do when we all pull together, and we have associations of manufacturers, organized to promote the respective branches of the industry in which they are engaged, which are highly successful examples of what can be done by the closest co-operation of the right kind.

"Let us as an association continue our work to the end that the transportation machine which means so much to this country be made an efficient weapon in the time of war and an aid to prosperity in the time of peace."

The secretary-treasurer's report was presented in detail and approved. A committee appointed to revise the constitution and by-laws presented its report through the chairman, M. J. Trees. This revision brought the constitution and by-laws into harmony with the practice which has been followed in recent years and was unanimously approved with practically no discussion.

The final order of business was the election of the list of new officers presented by the Nominating Committee, composed of P. W. Moore (P. & M. Co.), G. A. Blackmore (U. S. & S. Co.), L. Weston (Lack. Steel Co.), F. M. Condit (Fairbanks, Morse & Co.), and L. B. Sherman (Ry. Age. Gaz.). The officers who will serve for the coming year are: President, E. H. Bell (Railroad Supply Co.); vice-president, M. J. Trees (Chicago Bridge & Iron Works); secretary-treasurer, C. W. Kelly (Kelly-Derby Co.); directors for three years, E. E. Hudson (Waterbury Battery Co.), and F. J. Johnson (American Hoist & Derrick Co.).

NORTH WESTERN ROADMASTERS MEET

All of the roadmasters of the Chicago & North Western will meet today in the office of W. J. Towne, assistant general manager, to discuss the work for the coming year. This meeting is held at this time to enable these men to attend the exhibit at the Coliseum.

ROADMASTERS' ASSOCIATION MEETING

The executive committee of the Roadmasters' and Maintenance of Way Association will meet in the Auditorium Hotel at 10 o'clock this morning to discuss the work of this association and to prepare plans for the annual meeting, which will be held in Chicago next September.

COMMITTEES I AND X MEET

In spite of the announced intention of the committee in charge of the annual dinner of the members of Committees I and X of the R. S. A. and the A. R. E. A., respectively, to postpone this year's meeting on account of the lack of numbers, the clannishness of these signalmen would not permit them to leave without getting together. An informal dinner was therefore arranged for the Engineers' Club at 6:30 last night. The following were present to perpetuate the custom: A. G. Shaver, J. A. Peabody, T. S. Stevens, G. E. Ellis, M. H. Hovey and Azel Ames.

VALUATION HEARINGS AT WASHINGTON

By Our Washington Correspondent

Washington, March 20, 1917.

The hearing of the Interstate Commerce Commission on protests filed by the carriers against the tentative valuation reports on the Kansas City Southern, the New Orleans, Texas & Mexico and the Winston-Salem Southbound, has been in progress since Monday and is expected to last about two weeks. Aside from the matters above mentioned some additional testimony will be taken on the tentative valuations of the Texas Midland and the Atlanta, Birmingham & Atlantic. It has been agreed to consolidate the testimony in so far as it concerns the first three cases except as to certain questions raised by the representatives of the railways. S. W. Moore, general solicitor of the Kansas City Southern, objected to being bound in advance by any testimony as to the other roads. Director Prouty of the division of valuation was called as a witness by Pierce Butler, who asked several questions tending to bring out the expression of personal opinion, but Solicitor Farrell of the Interstate Commerce Commission objected to this, and his objection was sustained. Mr. Butler asked if the tentative valuation of the Texas Midland was prepared for the division of valuation or by the commission, to which Mr. Prouty replied that it was adopted by the commission and now stands as an act of the commission. Chairman Hall took the same position and expressed several definite objections to both the question and the answer. Mr. Prouty said he did not draft the report but that it had been carefully considered by the commission. E. T. Lamb, president of the Atlanta, Birmingham & Atlantic, testified regarding other values and development costs. W. G. Brantley asked the commission to report other values as a fact, even if it did not place a definite figure on them.

REGISTRATION—AMERICAN RAILWAY ENGINEERING ASSOCIATION

Abbott, F. E., Inspr. Engr., Lackawanna Steel Co., Buffalo, N. Y.
Ambrose, J. R. W., Chf. Engr., Toronto Term. Ry., Toronto, Ont., Canada.
Ames, Azel, Kerite Insulated Wire and Cable Co., New York.
Angerer, Victor, Vice-President, Wm. Wharton, Jr., & Co., Easton, Pa.
Angier, F. J., Supt. Tim., President, B. & O. R. R., Baltimore, Md.
Anthony, F. D., Const. Engr., D. & H. Co., Albany, N. Y.
Armour, Robert, Masonry Engr., Grand Trunk Ry., Montreal, Can.
Armstrong, H. J., Asso. Prof. C. E., Armour Inst., Chicago, Ill.
Arn, W. G., Asst. E. M. Way, I. C. R. R., Chicago, Ill.
Atwood, Wm. G., Asst. Dist. Engr., I. C. C., Chattanooga, Tenn.
Austill, H., Bridge Engr., M. & O. R. R., Mobile, Ala.
Bachelder, F. J., Consulting Engr., Chicago, Ill.
Baldridge, C. W., Asst. Engr., A. T. & S. F. Ry., Chicago.
Baldwin, A. S., President, Chf. Engr., I. C. R. R., Chicago, Ill.
Baldwin, R. A., Engr. M. W., Can. Nor. Ry., Toronto, Ont., Can.
Baluss, F. C., Engr. B. and B., D. M. & N. Ry., Duluth, Minn.
Bardwell, R. C., Asst. Engr., M. P. Ry., Kansas City, Mo.
Barry, H. B., Dist. Engr., S. L.-S. F. R. R., Chaffee, Mo.
Bassett, J. S., Asst. Eng., Mo. Pac. Ry., Monroe, La.
Batchellor, F. D., Dist. Engr., M. W., C. H. & D. Ry., Cincinnati, Ohio.
Beahan, Willard, First Asst. Engr., N. Y. C. R. R., Cleveland, Ohio.
Black, G. F., Engr. M. W., Maine Central R. R., Portland, Me.
Blaess, A. F., Engr. M. W., I. C. R. R., Chicago, Ill.
Bohland, J. A., Bridge Engr., G. N. Ry., St. Paul, Minn.
Bortin, H., Cons. Engr., New York City.
Boyd, James, Div. Engr., G. T. Ry., Hamilton, Ont., Canada.
Boykin, R. H., Div. Engr., Erie R. R., Marion, Ohio.
Bremner, Geo. H., Treasurer, Dist. Engr., Div. of Valuation, I. C. C., Chicago, Ill.
Briggs, Z. M.
Brown, A. V., Engr. M. W., Lake Shore Electric Ry., Sandusky, Ohio.
Brown, E. C., Chf. C. E., Carnegie Steel Co., Pittsburgh, Pa.
Brown, H. C., Jr., Chicago Bridge & Iron Works, Chicago, Ill.
Brown, J. M., Engr. M. W., C. R. I. & P., Topeka, Kan.
Brown, R. K., Engr. M. W., S. P. L. A. & S. L., Salt Lake, Utah.
Brown, S. P., Chf. Engr., Mt. R. T. & T. Co., Montreal, Canada.
Browne, H. L., Masonry Inspr., Rock Island Lines, Des Moines, Iowa.
Brunner, John, Asst. Inspr. Eng., Ill. Steel Co., Chicago, Ill.
Buehler, Walter, Cons. Engr., Wood Pres., Barrett Co., Chicago, Ill.
Burke, James, Supt. Chicago Ter. Div., Erie R. R., Chicago, Ill.
Burton, W. J., Asst. Engr., Mo. Pac. Ry., St. Louis, Mo.
Campbell, J. L., E. M. W., E. P. S. W. Ry. System, El Paso, Tex.
Carmichael, J., President, W. N. & M. Ry., Martinsburg, W. Va.
Case, A. D., Engr. Str., B. & A. R. R., Boston, Mass.
Chandler, Charles, Asst. Bridge Eng., I. C. R. R., Chicago, Ill.
Christian, W. A., Sen. C. E. in charge of Track and Roadway, I. C. C., Chicago, Ill.
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Church, S. R., Barrett Mfg. Co., New York, N. Y.
Cleveland, G. C., Chf. Engr., N. Y. C. R. R., west of Buffalo, Cleveland, Ohio.
Clift, A. E., Gen. Supt., I. C. R. R., Chicago, Ill.
Cochran, C. W., Winchester, Va.
Coles, W. C., Pilot Engr., B. & O. R. R., Wheeling, W. Va.
Connor, E. H., C. E., Mo. V. Br. & I. Co., Leavenworth, Kan.
Coon, C. J., Engr., Gr. Cen. Term., N. Y. C. R. R., New York, N. Y.
Cox, J. B., Cons. Engr., Chicago, Ill.
Crandall, C. L., Prof. of Ry. Eng., Cornell Univ., Ithaca, N. Y.
Crumpton, Arthur, Asst. Val. Engr., G. T. Rv., Montreal, Can.
Curd, W. C., Drainage Engr., Mo. Pac. Ry., St. Louis, Mo.
Curtis, L. G., Dist. Engr., B. & O. C. Ter. R. R., Chicago, Ill.
Davidson, Geo. M., Chemist and Engr. Tests, C. & N. W. Ry., Chicago, Ill.
Dansey, J. W., A. T. & S. F., Chicago, Ill.
Davis, A. L., Office Engr., I. C. R. R., Chicago, Ill.
Dayton, C. A., Ast. Engr., D. L. & W. R. R., Binghamton, N. Y.
Denney, C. E., Asst. to President, N. Y. C. & St. L. R. R., Cleveland, Ohio
Dennis, Walt, Asst. Engr., C., R. I. & P. Ry., Chicago, Ill.
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Dorley, A. F., Engr. M. W., East. Lines, M. P. Ry., St. Louis, Mo.
Dorrance, W. T., Chief Dr., N. Y. N. H. & H. R. R., New Haven, Conn.
Dougherty, C., Director, Ch. Engr., C. N. O. & T. P. Ry., Cincinnati, Ohio.
Dufour, F. O., Structural Engr., Stone & Webster Engr. Corp., Boston, Mass.
Dunham, Chas. A., Sig. Engr., G. N. Ry., St. Paul, Minn.
Earle, Thos., V. P., Bethlehem Steel Br. Corp., South Bethlehem, Pa.
Early, P. W., Mgr., Mason & Hanger Co., Clarksville, Tenn.
Edwards, J. H., Hamilton, N. Y.
Edwards, L. N., Supr. Engr. Bridges, Dept. of Works, Toronto, Can.
Edwards, W. R., Sen. St. Engr., I. C. C., Washington, D. C.
Ellis, G. E., Sig. Engr., Div. of Safety, I. C. C., Washington, D. C.
Evans, John, Div. Engr., M. C. R. R., Detroit, Mich.
Faulkner, L. E., Chief Engr., Miss. Cent. Ry., Hattiesburg, Miss.
Felt, C. W. F., Director, Chf. Engr., Santa Fe Ry. System, Chicago, Ill.
Fisk, C. H., Cons. Engr., St. Louis, Mo.
Fitzpatrick, P. D., Val. Engr., Cen. Vermont Ry., St. Albans, Vt.
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Ford, R. H., Eng., Tr. Elev., C. R. I. & P. Ry., Chicago, Ill.
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Fritch, E. H., Secretary, Chicago.
Fritch, L. C., Past-President, Gen. Mgr., Can. Nor. Ry. System, Toronto, Can.
Fulks, E. B., Vice-President, American Tar Products Co., Chicago, Ill.
Galbreath, W. O., Eng. Dept., C. G. W. R. R., Chicago, Ill
Gardner, W. H., Jr., Chf. Engr., G. & S. I. R. R., Gulfport, Miss.
Garner, R. D., Engr. Const., S. N. E. R. R., Providence, R. I.
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Gennett, C. W., Jr., Engr., R. W. Hunt & Co., Chicago, Ill.
Gerbach, Otto, E. M. W., Ind. Harb. Belt R. R., Gibson, Ind.
Gibboney, J. H., Chf. Chemist, N. & W., Roanoke, Va.
Gifford, Geo. E., Secretary, Bridge Builders' Society, New York, N. Y.
Gilcreast, F. W., Eng. Maint. L. & N. E. R. R., So. Bethlehem, Pa.
Gillen, U. E., Gen. Supt., G. T. Ry., Chicago, Ill.
Gillies, J. A., Engr., Southern Dist., A., T. & S. F. Ry., Amarillo, Tex.
Glass, R. G., Asst. Inspr. Eng., Ill. Steel Co., Chicago, Ill.
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Gold, M. H., Div. Engr., S. A. L. Ry., Savannah, Ga.
Gooding, W. J., Div. Engr., S. A. L. Ry., Jacksonville, Fla.
Goodrich, C. M., Des. Engr., Canadian Bridge Co., Walkerville, Ont.
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Harvey, W. C., First Asst. Engr., C. G. W. R. R., Chicago, Ill.
Hawk, A. T., Architect, Rock Island Lines, Chicago, Ill.
Hegel, G. W., Chief Engr., Chicago Junction Ry., Chicago, Ill.
Hench, N. M., Engr. Tr. Appl., Carnegie St. Co., Pittsburgh, Pa.
Hewes, C. A., Asst. Engr., M. P. Ry., Osawatomie, Kan.
Hewson, E. G., Div. Engr., G. T. Ry., Toronto, Ont., Can.
Hickey, T. H., Insp. of Track, M. C. R. R., Detroit, Mich.
Hill, G. D., Val. Dept., N. Y. C. R. R., Cleveland, Ohio.
Holden, J. C., Div. Engr., C. P. R., Winnipeg, Man., Can.
Houghton, E. R., Asst. Engr., U. P. R. R., Omaha, Neb.
Hovey, M. H., Cons. Engr., Madison, Wis.
Howson, E. T., Engr. Editor, Railway Age Gazette, Chicago, Ill.
Hoyt, W. H., Asst. Ch. Engr., D., M. & N. R. R. Duluth.
Hughes, L. J. F., Div. Engr., C. R. I. & P. Ry., Herington, Kan.
Humphrey, Richard L., Cons. Engr. and Chemist, Philadelphia, Pa.
Ibsen, Hans, Bridge Engr., M. C. R. R., Detroit, Mich.
Irwin, Chas. A., Asst. Engr., C. M. & St. P. Ry., Chicago, Ill.
Jacoby, H. S., Prof. of Bridge Eng., Cornell Univ., Ithaca, N. Y.
Jenkins, J. B., Val. Engr., B. & O. R. R., Baltimore, Md.
Johnson, Maro, care Eng. Dept., I. C. R. R., Chicago, Ill.
Johnston, A. W., Past-President, Asst. to President, N. Y. C. & St. L. R. R., Cleveland, Ohio.
Ketchum, M. S., Prof. C. E., Univ. Colo., Boulder, Colo.
Khuen, Richard, Gen. Mgr. Erect., Am. Bridge Co., Pittsburgh, Pa.
Kinney, W. M., Inspr. Eng., Universal Portland Cement Co., Chicago, Ill.
Knickerbocker, C. E., I. C. C., Washington, D. C.
Knowles, C. R., Gen. For. Water Works, I. C. R. R., Chicago, Ill.

Koppisch, C. F., Res. Engr., S. N. E. R. R., Brimfield, Mass.
Kuehn, A. L., Gen. Supt., American Creosoting Co., Chicago, Ill.
La Bach, Paul M., Asst. Engr., C., R. I. & P. Ry., Chicago, Ill.
Lacher, W. S., Asst. Engr. Editor, Railway Age Gazette, Chicago, Ill.
Lahmer, J. A., Asst. Engr., Mo. Pac. Ry., St. Louis, Mo.
Lakin, F. D., Div. Eng., Erie R. R., Huntington, Ind.
Landorph, E. L., Engr. Water Ser., C. P. Ry., Winnipeg, Can.
Larsen, Albert, Res. Engr., S. N. E. Ry., Providence, R. I.
Larsson, C. G. E., Asst. Chief Engr., Am. Bridge Co., New York.
Layng, F. R., Engr. Track, B. & L. E. R. R., Greenville, Pa.
Lee, E. H., Vice-Prest. and Ch. Engr., C. & W. I. R. R., Chicago, Ill.
Lee, Frank, Prin. Asst. Engr., Can. Pac. Ry., Winnipeg, Man.
Leffler, B. R., Engr. Bridges, N. Y. C. R. R., Cleveland, Ohio.
Leisenring, J. G. M., Sig. Engr., Ill. Trac. System, Springfield, Ill.
Lewis, E. R., Asst. to Gen. Mgr., D. S. S. & A. R. R., Duluth, Minn.
Lewis, P. S., Supervisor, P. & R. Ry., Philadelphia, Pa.
Lindsay, C. E. (Director), Div. Engr., New York Central R. R., Albany, N. Y.
Long, M. A., Asst. to Ch. Engr., B. & O. R. R., Baltimore, Md.
Lozier, W. L., Res. Engr., D. L. & W. R. R., Kingsley, Pa
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MacFarland, H B., Engr. of Tests, A. T. & S. F. Ry., Chicago, Ill.
Mackenzie, A. C., Engr. M. W., C. P. R., Montreal, Can.
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Mann, B. H., Sig. Engr., Mo. Pac. Ry. System, St. Louis, Mo.
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Michel, Wm., Ch. Engr., Hocking Valley R. R., Columbus, O.
Mielly, W. E., 10 South La Salle St., Chicago, Ill.
Mitchell, Geo. A., Supt. B. & B., G. T. Ry., Toronto, Ont., Can.
Mitchell, L. A., Supt. Roadway, United Trac. Co., Anderson, Ind.
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Moodie, W. T., Div. Engr., Can. Nor. Ry., Winnipeg, Man., Can.
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Mullen, Joseph, Spl. Asst. Engr., C. C. C. & St. L. Ry., Cincinnati, Ohio.
Neff, F. H., Prof. C. E. Case School Appl. Sci., Cleveland, Ohio.
Nelson, J. C., Eng. M. W., S. A. L., Norfolk Va.
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Norris, W. H., Bridge Engr., Maine Central Ry., Portland, Me.
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Peabody, J. A., Sig. Engr., C. & N. W. Ry., Chicago, Ill.
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Pfafflin, E. H., Ch. Engr., C. T. H. & S. E. Ry., Chicago, Ill.
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Pinner, Guy, Bridge Engr., Seaboard Air Line, Norfolk, Va.
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Puder, F. R., Asst. Engr., C. T. H. & S. E. Ry., Chicago, Ill.
Raymond, W. G., Dean, Col. Appl. Sci., State Univ. Iowa, Iowa City, Iowa.
Reagan, J. H., Supt. Track, Grand Trunk Ry., Chicago.
Reichmann, Albert, Div. Eng., Am. Bridge Co., Chicago, Ill.
Reid, J. W., Bridge Engr., C. & A. R. R., Chicago, Ill.
Rex, George E., Mgr., Treating Plants, Santa Fe Sys., Topeka, Kan.
Rice, S. B., Engr. M. W., R. F. & P. R. R., Richmond, Va.
Ridgway, A. O., Asst. Ch. Engr., D. & R. G. R. R., Denver.
Riggs, H. E., Prof. of Civ. Engr., Univ. of Mich., Ann Arbor, Mich.
Ripley, H. L., Val. Eng., N. Y. N. H. & H. R. R., Boston, Mass.
Roach, J. A., Div. Engr., A. T. & S. F. Ry., East Las Vegas, N. M.
Roach, J. H., Engr. Val., N. Y. C. R. R., Cleveland, Ohio.
Roberts, S. S., Cons. Engr., Chicago, Ill.
Robinson, A. F., Bridge Engr., Santa Fe Ry. Sys., Chicago, Ill.
Rote, R. O., Asst. to Ch. Engr., N. Y. C. R. R., Cleveland, Ohio.
Rust, T. E., Ch. Engr., W. C. F. & N. Ry., Waterloo, Ia.
Rys, C. F. W., Met. Engr., Car. St. Co., Pittsburgh, Pa.
Safford, H. R. (Director), Ch. Engr., Grand Trunk Ry. Sys., Montreal, Can.
Sattley, R. C., Val. Engr., C. R. I. & P. Ry., Chicago.
Sawyer, Mott, Supt., C. M. & St. P. Ry., Spokane, Wash.
Schofield, J., Architect, Can. Nor. Ry., Winnipeg, Man., Can.
Selby, O. E., Prin. Asst. Engr., C. C. C. & St. L. Ry., Cincinnati, Ohio.
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Slifer, H. J., Cons. Engr., Chicago, Ill.
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Smith, C. E., Cons. Engr., St. Louis, Mo.
Smith, D. W., Val. Engr., Hocking Valley Ry., Columbus, Ohio.
Smith, F. A., Civil Engr., Chicago, Ill.
Smith, J. E., Instr. C. E., Univ. of Ill., Urbana, Ill.
Smith, Lowry, Supt. Tie Treat. Plants, Nor. Pac. Ry., Brainard, Minn.
Spencer, C. H., Dist. Engr., I. C. C., Div. Val., Washington, D. C.
Sperry, H. M., Director Bureau of Ry. Signaling Economics, New York, N. Y.
Spielman, J. A., Dist. Engr., B. & O. R. R., Pittsburgh, Pa.
Stein, C. H., Supt., C. R. R. of N. J., Jersey City, N. J.
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Unger, J. S., Mgr., Research Lab., Carnegie Steel Co., Duquesne, Pa.
Van Auken, A. M., Cost Engr., M. C. R. R., Detroit, Mich.
Vandersluis, W. M., Sig. Eng., Ill. Cent. R. R., Chicago, Ill.
Vanneman, C. R., Ch., Div. Trans., Public Service Com., Albany, N. Y.
Von Schrenk, Hermann, Dr., Cons. Timber Engr., St. Louis, Mo.
Votey, J. W., Prof. C. E., Dean Col. Engr., Univ. Vt., Burlington, Vt.
Wallace, W. A., Chicago, Ill.
Walling, V. R., Prin. Asst. Engr., C. & W. I. R. R., Chicago, Ill.
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Weir, John M., Div. Engr., K. C. S. Ry., Pittsburg, Kan.
Welty, H. T., Engr., St., N. Y. C. R. R., New York City.
Wickhorst, M. H., Engr. of Tests, Rail Committee, Chicago, Ill.

Wilgus, H. S., Engr. M. of W., P. S. & N. R. R., Angelica, N. Y.
Williams, S. N., Prof.-Emer. of Civ. Engr. (Cornell College, Iowa), Oak Park, Ill.
Wilson, C. A., Cons. Engr., Cincinnati, Ohio.
Wilson, G. L., Engr. M. W., Twin City Rapid Transit Co., Minneapolis, Minn.
Wiltsee, W. P., Asst. Engr., N. & W. Ry., Norfolk, Va.
Wishart, J. G., Office Engr., C. R. I. & P. Ry., Chicago, Ill.
Wolfel, P. L., Ch. Engr., McClintic-Marshall Co., Rankin, Pa.
Yager, Louis, Div. Engr., Nor. Pac. Ry., St. Paul, Minn.
Yates, J. J., Bridge Engr., C. R. R. of N. J., New York, N. Y.
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Young, R. C., Ch. Engr., L. S. & I. and Munising Rys, Marquette, Mich

SOME CONSTRUCTION CONTRACTS

The Jacksonville (Fla.) Terminal Company has awarded a contract to Irwin & Leighton, Philadelphia, Pa., for the construction of a passenger station, baggage building and subway at Jacksonville, Fla., at an estimated cost of $750,000.

The Lehigh Valley has awarded a contract to the R. D. Richardson Contracting Company, Scranton, Pa., for the construction of a freight terminal at Hazelton, Pa., including a freight station 300 ft. by 40 ft.

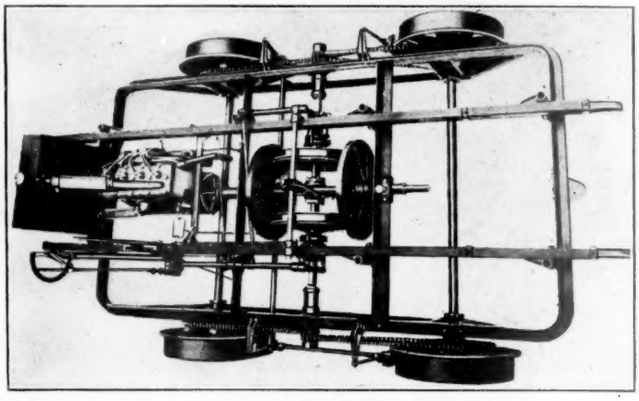
ENGINEERING SOCIETIES MEETING

A meeting of representatives of the different railway engineering and maintenance of way associations was held in the green room of the Congress Hotel last evening to discuss plans for the possible co-ordination of the work of these organizations. President Baldwin of the American Railway Engineering Association presided. Representatives were also present from the Railway Signal Association, the American Railway Bridge and Building Association, the Roadmasters' and Maintenance of Way Association, the American Wood Preservers' Association, the Maintenance of Way Master Painters' Association, the Association of Railway Electrical Engineers, the Railway Fire Protective Association and the American Electric Railway Association. The movement originated with the American Railway Association and has for its object the harmonizing of the recommendations of different railway organizations, and also the elimination of unwise action by any association which might reflect against the railways.

A NOVEL MOTOR CAR

A car with an automobile type engine, with a gearless drive that transmits power to all four wheels, yet with all wheels loose on the axles and with arrangements that permit of the use of power tools, represents an interesting innovation in railway power operated section or gang cars of recent introduction. The salient features of this motor car can be seen in the two illustrations, one of which shows a plan of the car with the floor removed. The unique feature of the operating arrangement is based on the use of a duplex friction clutch system. Two driving discs are mounted on the engine shaft a sufficient distance apart so that two driven discs can be placed between them in a perpendicular position that will allow a slight clearance between the driving and the driven discs. The latter are mounted on independent shafts, each transmitting power to one side of the car only, through sprocket chains to each wheel. The shafts on which these driven discs are mounted can be given a slight angular movement in a horizontal plane so that the discs may come in contact with one or other of the driving discs. Since the latter necessarily rotate in the same direction it is necessary that the contact between driving and driven discs be always diagonally opposite—that is, the two driven discs are never in contact with the same driving discs. This arrangement serves to counter-balance the contact pressures and obviates the need of a thrust bearing on the engine shaft.

To reverse the car each driven disc must change its contact to the opposite driving disc. This movement is



Plan of the Car with Floor Removed

controlled by a lever which is also used to shift each of the driven discs latterly on its shaft, thereby changing the points of contact between the driven and the driving discs with respect to the axis on the engine shaft. Thus one lever serves both to change the speed and reverse the direction, giving an unusually simple control.

The wheels are 20 in. in diameter and the wheel base is 48 in. The platform is 8 ft. long by 5 ft. 3 in. wide. The frame consists of 3-in. by 2-in. angles covered with a plank floor, and seats are provided for eight men. The cars are furnished with canopy tops. The weight of the car is 1,100 lb., but owing to the fact that the engine is located entirely in the overhang at one end of the car the weight to be lifted in raising the wheels at the oppo-

The Car Complete

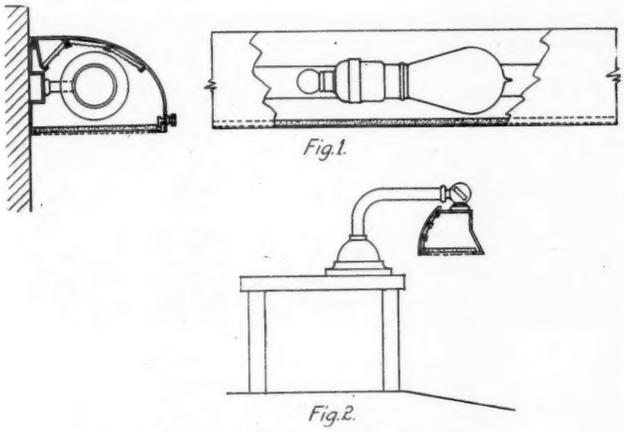
site end of the car when unloaded is said to be well within the lifting capacity of one man and with the wheels free to turn on the axles the car is easily swung around perpendicular to the track. Another provision which aids materially in handling the car on and off the track is the fact that the transmission arrangement permits of a very slow speed. In consequence the car is readily han-

dled off the track and on rough ground with its own power. This ability to move at extremely slow speed gives a high torque, and it is claimed that it makes it possible to move much larger trailing loads with this car than can be handled at the slowest speed at which most motor cars are geared to run.

The engine is arranged to burn kerosene or distillate oil. It is of the four-cycle oil-cooled type, rated at 18 hp. Speeds in excess of 30 miles an hour may be obtained with these cars, but the governor may be set to keep the speed within any maximum limiting speed that is found desirable. The driving shaft is equipped with an extension arranged for the connection of flexible shafting to which various kinds of tools may be attached for work on the track. The cars will also be furnished with air compressors if desired for the use of pneumatic tools. These cars have recently been placed on the market by the Railway Motor Car Company of America, Chicago, Ill., after a period of extensive tests.

NEW LIGHTING FIXTURES

A new line of lighting fixtures has been developed for application to ticket windows, bookkeepers' desks and similar locations. These fixtures are so arranged that the source of light is practically concealed from vision at any angle and is invisible to the eye of one working under the illumination of the particular unit involved, the result being that a thoroughly diffused illumination is evenly distributed over the working surface while no derogatory effects are had because of glare or the existence of bright sources of light within the field of vision of the operator.



Details of the Concealite Fixtures

An arrangement of this sort has been proven by test to increase the efficiency of employees working under the illumination materially, and in view of the fact that it dispenses entirely with brackets, pendant shades, bare lamps, etc., such as are commonly used for service of this character, it makes a decided improvement in the appearance of offices or other locations in which it is used.

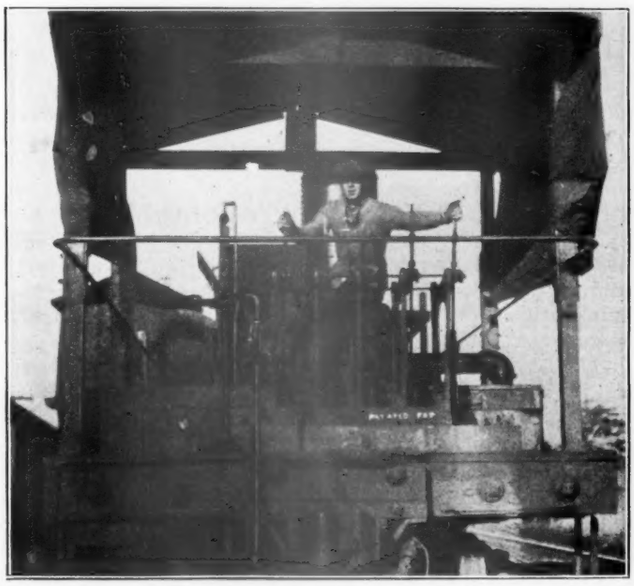
Fig. 1 shows the transverse and longitudinal section of a reflector for application to the inside of a railway ticket window cornice or similar location. The lamps are enclosed in a metal frame equipped on the inside with diffusing reflectors and enclosed on the under side with diffusing glass. The enclosure is of sufficient size to accommodate 25, 40 or 60-watt lamps with a twin socket for each, 24 in. in length. Fig. 2 shows a cross section of a diffusing reflector for the top of a bookkeeper's desk. These reflectors can be secured in any length desired with supports spaced about every four feet. They are available in the single type as shown or in a double form with reflectors on each side of the supports. A wall type provided with supports to be attached to the wall can also be had. These new lighting fixtures are manufactured by the St. Louis Brass Manufacturing Company, St. Louis, Mo., and are known as Concealite fixtures.

RESULTS OF CHEMICAL WEED KILLING

The Chipman Chemical Company, New York, successors to the Atlas Preservative Company of America, for several years past has been manufacturing Atlas "A" weed killer and track preservative. The chemical has been used extensively by various railroads and it is now possible to summarize some of the results obtained, the quantities of liquid necessary for effective treatment and the average daily mileage it is possible to treat successfully under varying conditions.

Chemical Train on the Southern

Atlas "A," which is a chemical combination designed to eradicate vegetable growth, is furnished in a concentrated form so that it may be shipped economically to the point of use. Before its application the chemical is diluted with water to form a clear, odorless and stainless liquid. When it is necessary to prevent cattle from grazing on the treated vegetation, an odorous compound is also applied.



Control Quadrant at End of the Car

While the treatment may be applied by the railroad if

desired, generally the chemical company contracts for its application and supplies the sprinkling equipment suitable to the mileage to be treated. It also furnishes a superintendent to take charge of the equipment, who is familiar with its operation and the character and resistive nature of the weed growth. The equipment used for extensive treatment was described in the October issue of the Railway Maintenance Engineer.

During 1916, the equipment was used on the Southern to treat 1,058.8 miles of line to the width of 14 ft. The work was done in 16 days, thus maintaining a daily average of slightly more than 66 miles of track treated per day. On an average 56 gal. of liquid were used per mile. As the Southern has used the treatment for the past three years, the greater part of the mileage was second and third year application. In consequence the number of gallons used per mile was less than that normally required for an initial application. The amounts of chemical necessary for successive treatments diminishes progressively as the track is rendered more sterile.

Among other roads that are extensive users of the chemical may be mentioned the Chicago & North-Western and the Seaboard Air Line. During 1916 the former treated 721.4 miles of track to an average width of 14 ft. The work was done in 18 days or at an average of 40 miles per day and 62 gal. of liquid was used per mile. On the Seaboard, 222.4 miles of track was treated in 1916 to a width of 14 ft., using 94 gal. of liquid per mile. This work was done in four days.

In the fall of 1916, after the treatment had been applied on these roads, inspection trips were made to gain information as to the general results. The weed growth reported as occurring on the southern roads was limited to Bermuda grass and on the northern roads to occasional growth of horsetail, at places where the treatment given was light.

The Erie used the Atlas "A" method for the first time in 1916, making a treatment of 14 ft. in width over 178.1 miles of track, using 77.9 gal. of liquid per mile. The quantity, while low, was sufficient, as the weed growth was confined mainly to the outer shoulder.

THE USE OF GUNCRETE FOR STEEL PROTECTION

At the east end of the Forty-second street tunnel of the Interborough Rapid Transit under the East river at New York, the tracks rise and pass over yard tracks of the Long Island Railroad, continuing from this point as an elevated railway. The five spans of this elevated structure which pass over the Long Island tracks are subjected to the corrosive action of the gases as well as the blast action from the stacks of the locomotives, and as there are frequent switching movements on the tracks this steel work is subjected to extraordinarily severe conditions.

The bottoms of the main girders of the structure are 21 ft. above the top of rail of the yard tracks. The main girders carry cross-girders, which in turn carry stringers on which are placed ties carrying two tracks and third rails.

The plan adopted for protecting this steel work was to cover it with a coating of concrete. American Steel & Wire Company triangular mesh No. 7A was applied to all of the steel members, including the main girders, cross-girders, stringers, columns and lateral bracing. This wire was carried over the tops of the stringers between the ties by cutting the wire away where the ties rested on the stringers and lapping the wire over between the ties. "Gun-crete," also called "gunite," was then shot in place with cement guns, encasing all the steel work with an average thickness of 1½ in., the wire reinforcement being approximately in the center of the "gun-crete." This material consisted of a mixture of one part of Portland cement and 3½ parts of clean, sharp, sand. It was mixed dry before being placed in the guns and was forced into place with an air pressure of approximately 35 lb. per sq. in., water being added at the nozzle.

The columns were shot full to finish them to a square cross-section. Angle-iron bracing was filled on the inside of the angles to give a roughly triangular section. On main girders and cross-girders the contour lines were followed, edges being struck off straight and surfaces flat to leave a panel effect, as shown in the illustration. Where the "gun-crete" extended over the tops of the stringers between the bays it was kept away from the ties by first placing strips of thick tar paper against the ties. This gave a measure of elasticity for contraction and expansion of the ties, so that swelling resulting from absorption of water should not crack off the encasement of the tops of the stringers between the ties.

As this work had to be done without interrupting traffic, all work which had to be done from below was carried out on swinging scaffolds clearing the tops of the rails by 17 ft. This left approximately 4 ft. of space in which the work had to be done. These scaffolds, or swinging platforms, were carried on "U" hangers made of ¾-in. round iron so shaped that they could be hooked over the ties. The hangers carried 2-in. by 4-in. joists on which the platform planking was laid. The working conditions were extraordinarily severe because the locomotives were just as liable to stop under the bridge as elsewhere, and in starting trains under these conditions the blast of the locomotive would lift planking off the platform.

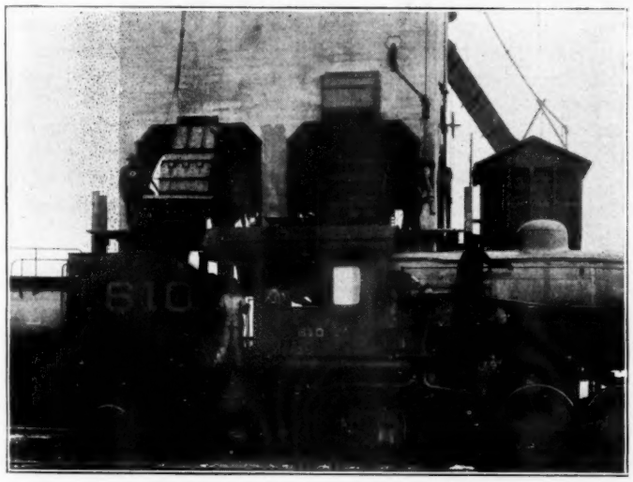
A Portion of the Finished Structure

The picture shows the section spanning the tracks complete as protected with "gun-crete." Some of the columns are shown awithout protection at the bottom ends, as these were later protected by building collision bulkheads extending from column to column and surrounding them.

The work of applying the "gun-crete" was done by the Cement-Gun Construction Co., Chicago, Ill., for the Degnon Contracting Co., New York City, general contractor for the entire work, all of it being done under the direct supervision of the Public Service Commission of New York City. The work was started on September 6, 1916, and finished on December 1.

CHECKING COAL CONSUMPTION

J. W. Kendricks' report on the Missouri, Kansas & Texas contains the following statement: "No system of fuel disbursement is complete or satisfactory that does not afford a practically constant check upon the amount of coal used by any engine upon any trip in any class of service." That this view is held by others is borne out by the contract recently let by the Lehigh Valley for a large coaling station at Manchester, N. Y., in which provision is made for 14 "Rands" measuring coal loaders to be furnished by Roberts & Schaefer Company, Chicago, the contractors for the entire station.



The Rands Coal Loader in Service

The measuring coal loader which was described in the daily issuue of the *Railway Age Gazette,* March 22, 1916, page 614, is a device by means of which the coal is measured as it flows from a storage pocket of the coaling station into the engine tender. The device will operate at the rate of four tons per minute and the amount of coal taken is recorded on a gear-operated counter. Three of these coal loaders have had nearly a year's service in a coaling station on the Nashville, Chattanooga & St. Louis at Cowan, Tenn., where an average of about 35 engines have been served daily during that time and it is estimated that an aggregate of 90,000 tons of coal has been measured. A somewhat unusual application of this device is to be made at Chelyan, W. Va., where the Chesapeake & Ohio locomotives are to be supplied with coal direct from a mine, and the record secured by the measuring loader is to be used as the basis for payment to the mine owner for the coal furnished.

A NEW LIGHT MOUNTAIN TRANSIT

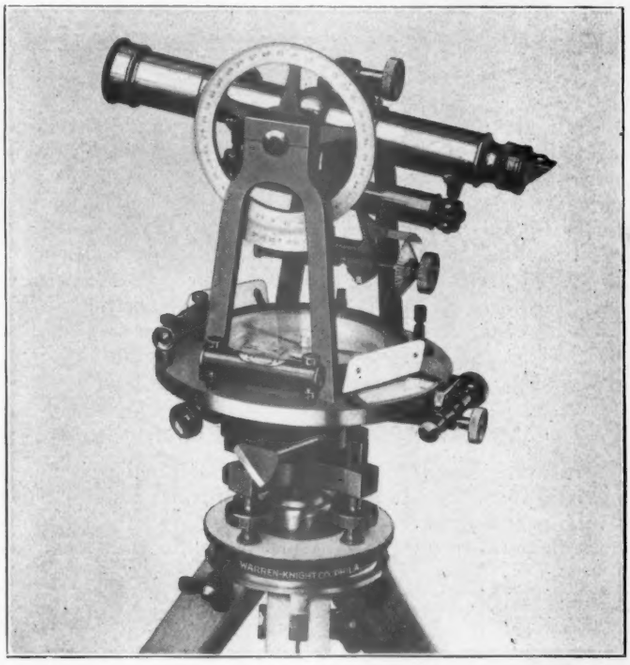
The Warren-Knight Company, Philadelphia, recently introduced a Model No. 6 Sterling light mountain transit that is of interest because of several novel features. The balanced telescope, which is 9 in. long, is fitted with a high-power eyepiece with a spiral screw focussing head, and a minimum focal range of about 4 ft., a new form of disappearing stadia and a right-angle peep sight through the telescope axle. The telescope level is 4 in. long and graduated to 40 sec.

The short focus feature is of special advantage in locating offsets in curve and switch work, as is also the right-angle peep sight. In the new form disappearing stadia the stadia wires only disappear, the cross-hairs remaining in focus with or without the stadia. Thus the advantages of the fixed stadia are retained, while the convenience of one equipped with the plain cross-wires is secured when doing level work in that it eliminates the danger of errors in rod readings arising from using the wrong wire.

The top plate is 6 in. in diameter and is rib-cast. The horizontal limb reads to single minutes by two opposite double verniers located at 30 deg. with the line of sight and numbered from 0 to 360 deg. each way. The figures are inclined in the direction of reading. The plate levels are mounted directly on the top plate, and at the maximum distance from its center.

The vertical circle, which has five spokes, is 3¾ in. in diameter, and is equipped with a double vernier which reads to single minutes. The compass is provided with a 3¼-in. bar needle swung on a hardened steel center pin. The graduation is in quadrants. The interior variation plate is dustproof and is moved by a rack and pinion.

The instrument has a non-cramping level head, a liberal shift and a wide angular range. The leveling screws are fitted in replaceable bushings and are provided with dust caps and ball socket shoes. The tangent screws are provided with adjustments for taking up wear.



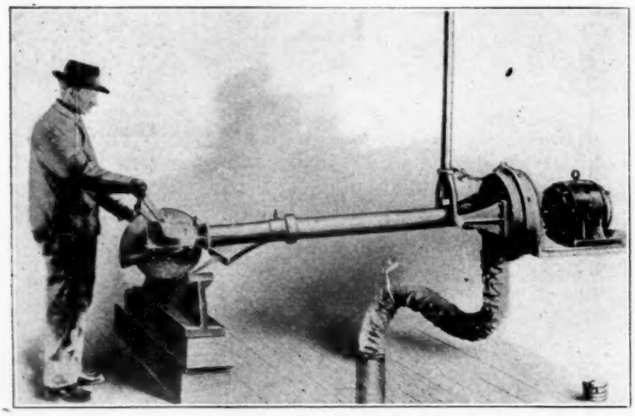
The Sterling Transit

A SWING FRAME GRINDER

The Frog Switch & Manufacturing Company, Carlisle, Pa., has introduced a swing frame grinder with a fan attachment that is applicable for use in maintenance of way repair shops for the repair or resurfacing of manganese frogs and other special track work. As shown in the photograph, the machine has a direct motor drive and is equipped with a fan attachment to carry off the dust. The grinding wheel is 14 in. in diameter and is driven by a 3 hp. motor supported on a rack attached to the back of the fan case. The motor is direct connected to the driving shaft and drives the grinder through two manganese steel gears. It is claimed for the device that the direct motor drive lessens the cost of operation of this machine in comparison with the belt-driven type, where the

location of the belt makes it impossible at times for a workman to prevent the belt from coming in contact with the work being ground.

The steel blade fan which carries off the dust is 14 in. in diameter and is enclosed in a tight-fitting two-piece cage with all moving parts thoroughly guarded. It is



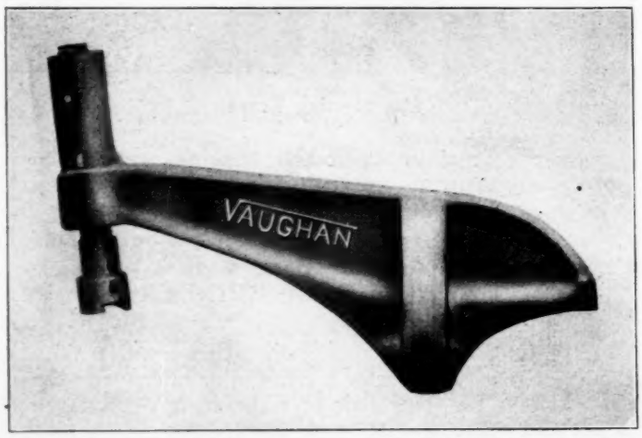
Grinding a Casting

connected with the main driving shaft and travels at 1,800 revolutions per minute when the machine is doing normal work. The dust is carried off through the machine and fan and delivered to a convenient place for final disposal through a wire reinforced fabric hose.

The machine is equipped with Hyatt flexible roller bearings, is carefully balanced and when equipped with a new wheel the driving shaft is in a horizontal position. The balance is maintained as the grinding wheel wears smaller by a weight rack equipped with a set of small cast iron weights placed just behind the motor.

AN IMPROVED RAIL BENDER

The Vaughan Type Samson rail bender which is being introduced by the M. W. Supply Company, Philadelphia, contains a number of improvements over the original Samson rail bender. One of the most important changes

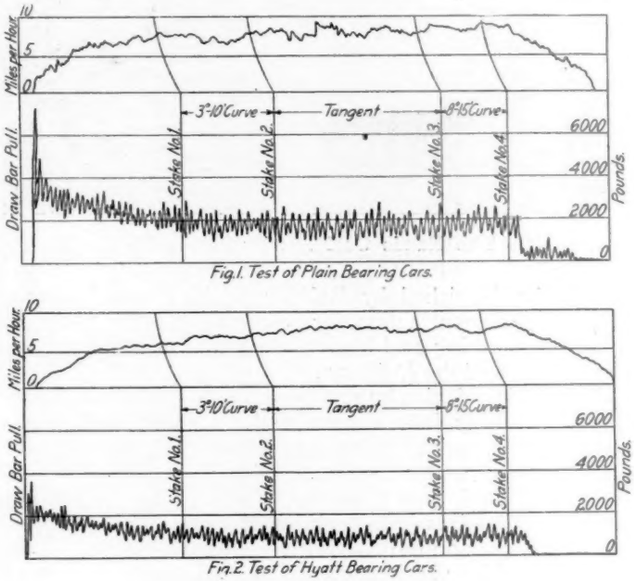


The Vaughan Type Sampson Bender

is the packing of the screw in grease and its encasement to protect it from rough handling and from dust and grit. Another development is the location of the capstan head close to the rail, whereby the bearing surface in the shoe is increased 80 per cent without changing the size of the screw in any way. This also prevents the cutting of the ends of the screw or the shoe by the heavy pressures created at that point. This bender, the frame of which is of crucible steel, is made in two sizes, No. 1 for 150-lb. and lighter sections of rail, and No. 2 for 100-lb. and lighter sections. The No. 1 bender weighs 200 lb. and the No. 2, 125 lb.

TESTS ON JOURNAL FRICTION

The increasing cost of the fuels used in operating motor cars would tend to cause considerable discouragement among the railway officers who have been urging the extended use of power operated cars for section and other gangs in maintenance work, were it not for the fact that material reductions in the consumption of fuel have been secured by the use of low friction bearings on these cars. The Hyatt roller bearings, which are now being applied to a considerable number of makes of motor cars used in railway maintenance service, have not been subjected to any comparative tests on railway cars, but recent experiments made with mine cars demonstrate the advantage of the low friction bear-



Diagrams of the Results Secured

ing on cars coming within the same range of loading as those used in railway service.

The tests were made at Carbondale, Pa., in two trains of cars of exactly the same construction except that in one train the cars were equipped with plain bearings and in the other with roller bearings. In both cases the bearings were housed in cast-steel frames with self-alining bearing blocks. The plain bearings were fitted with cast-steel oil reservoirs. Each train weighed approximately 40 tons and consisted of 10 mine cars hauled by a small steam locomotive with a specially designed dynamometer car between the locomotive and the first mine car. This was equipped to make automatic records of the draw-bar pull, speed and time. The test was made on the main haulage track outside of the mine on an upgrade averaging 0.45 per cent. There were two curves in the track, one of 3 deg. 10 min. and the other of 8 deg. 15 min., the curves occupying about one-half of the test distance.

The results of these tests are given in the diagram, Fig. 1, showing the record of the run made with the plain bearing cars. In making the start the draw-bar pull jumped to 7,400 lb., falling off as the starting resistance was overcome. The run between stakes, num-

bers two and three, was taken as representative and gave an average draw-bar pull of 1,700 lb. at an average speed of 8 miles per hour. Correcting this for the 0.45 per cent grade gives 1,327 lb. or a pull of 32 lb. per ton of load.

In the case of the train equipped with the roller bearings the draw-bar pull at the start was 3,700 lb., reducing between stakes two and three to an average of 900 lb. at a speed of 7.8 miles per hour. Correcting this for grade the equivalent draw-bar pull for level track is 532 lb. or 13 lb. per ton. From this it is seen that the average general resistance of the plain bearings while running is two and one-half times that for the roller bearing. The roller bearings used in this test were manufactured by the Hyatt Roller Bearing Company, Newark, N. J.

U. S. & S. STYLE AH CROSSING BELL

The Union Switch & Signal Company, Swissvale, Pa., has developed an alternating current crossing bell of the electro-magnet type. In size and general features, it is identical with the Style D-H direct current crossing bell, the operating mechanisms of the two being interchangeable. The operating magnet is the same as that of the "slot" used on the style S alternating current signal; its coils are spool wound, easily replaced, and insulated to meet R. S. A. requirements. It can be wound for any standard voltage and frequency; its power requirements are low.

The contact is simple, rugged and easily inspected; its parts may be easily replaced when worn. The counterweighting is such that the bell cannot stick with the contact open. For mounting the contact and the non-turning terminal posts a porcelain terminal block is used.

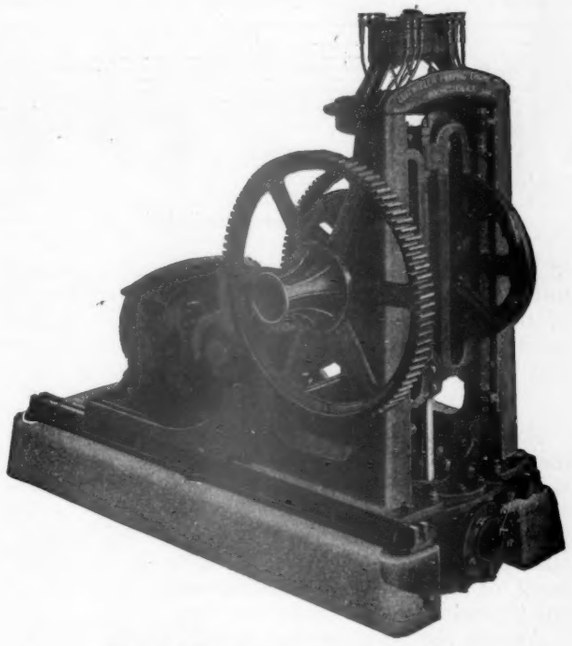
An adjustment is provided by which the frequency and the intensity of the strokes can be varied through a wide range. The bearings are of special non-corrosive materials. Endurance tests have demonstrated that this bell will operate over a long period of time, and require a minimum amount of maintenance.

ECONOMY IN PUMPING WATER

Investigations of railway water stations containing pumping units which were installed before pumping machinery had reached its present stage of development will almost invariably show that material reductions in pumping costs can be secured by replacing the antiquated equipment by modern machinery. As an example of this may be mentioned the results secured with the non-pulsating system of pump manufactured by the Luitwieler Pumping Engine Company, Rochester, N. Y.

As applied to deep well pumping these pumps consist of a pumping head operating two pistons working in a barrel placed at any desired elevation in the well casing. The pistons are actuated by two rods, one of which is attached to the lower piston and works inside of the second piston rod which is hollow and is attached to the upper piston. In place of the usual cranks these piston rods are actuated by cams of such shape that the velocity of the rods is practically constant throughout the entire length of the upward stroke. In addition there is an overlap in the upstrokes of the two rods and as a result the water moves upward through the discharge pipe at virtually a constant velocity. This eliminates the loss of power incident to the usual variations in the velocity head obtaining in reciprocating pumps. The foot valve in these pumps remains open as long as the pump is in motion and the operation is so uniform that the pumping head works with almost an entire absence of vibration.

At Sturgis, Mich., the New York Central installed one of these pumping units rated at 100 gal. per min., the pumping head being driven by a 10-hp. motor. The cost of the pump and motors installed in place with all the necessary changes in piping, etc., was $1,450. Alterations to the well were $624, making a total cost of $2,074 for changes to the plant effecting the economy of pumping. The record of the cost of operating this pump for a period of ten months showed that the average cost of current per month was $16 at 6½ cents per kilowatt hour. Attendance was $5 per month, paid to the baggage man at the adjoining station and maintenance amounted to an average of $3.63, making a total of $24.63 per month against $120, the estimated cost for pumping the same quantity of water with a steam pumping plant of the usual type.



Electrically Driven Pumping Head

STEEL FENCE POSTS

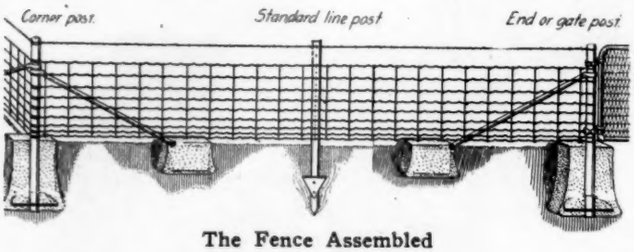
Steel fence posts with a number of distinctive features are being manufactured by the Chicago Steel Post Company, Chicago, Ill. The line post is an angle-shape, pointed at the base for easy driving. The feature of its design is the location of the triangular-shaped anchor plate near the base, so that when it is placed the anchor is in solid earth below the ground line. By this means the post is held in line and the soft earth at the ground line acts as a cushion to absorb shocks.

The fence is fastened to the post by common 1½-in. staples first placed on the wire and then through oval slots provided in the face of the post. The upper leg of the staple is then bent upward and the lower leg downward. As the points of the staple are turned in against the angle, there are no sharp points to injure persons or stock. A one-man stapling tool is provided for clinching the staples.

The corner, gate and end posts are made from steel tubing, thus making them equally strong in all directions. They are the same size throughout and are, therefore, of the same strength at all points. The brace used is adjustable and is attached to the posts by means of a collar that can be moved up and down

on the post freely to conform to the contour of the ground. By loosening the bolts, the collar can be moved sideways on the post, making it possible to run the fence line at any angle from the upright. Through the adjustable feature, the post can be braced on two or four sides.

The manufacturer also furnishes anchor line posts. The former are similar to the ordinary line posts, but are equipped with a circular plate that rests on the triangular anchor plate. To use the post, a hole 12



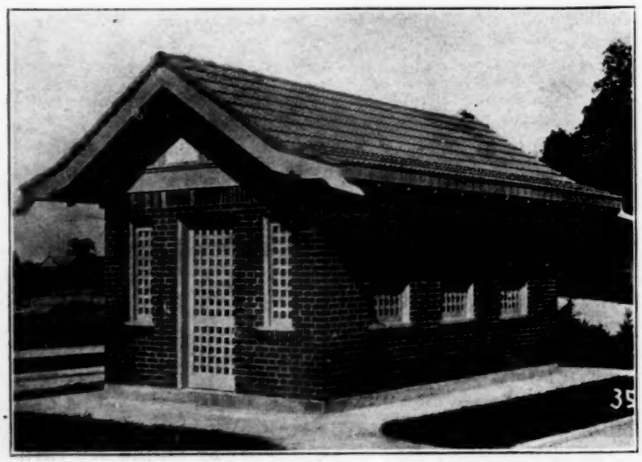
The Fence Assembled

in. deep is first prepared and the post is then driven until the triangular flange is flush with the bottom of the hole. The circular plate is then applied and the hole is filled with firmly tamped earth or stone.

CONCRETE ROOFING TILE

Rapid growth has recently been made in the development and use of concrete roofing tile. Large concrete slabs have been in use for some time for roofs of industrial buildings, factories, warehouses, train sheds and similar buildings. More recently roofing tile of small sizes have been developed, especially since the establishment of factories for manufacturing concrete roofing tile in various parts of the country.

Among the developments is that of the Walter Concrete Machinery Company, Indianapolis, Ind., consisting of a machine production of roofing tile applicable to houses, garages, railroad stations and other small railway buildings. The machine is operated by hand and an average of 350 to 400 tile can be made per day. After a few days' time, it is said that a common laborer can be taught



A Shelter Building Roofed with Walter Tile

to make this number consistently, while some operators exceed 500 with little practice.

Tile made this way are ⅜ in. thick, 14½ in. long and 9½ in. wide. They interlock at the sides and lap on the ends, covering a space 8 in. by 12 in. and require 150 tile to make one square of 100 sq. ft. They are easily put in place on the roof, because they need merely be hung on wooden cleats that also hold the roofing paper in place. A square weighs but 700 lb., and when being shipped stacks into a small space. They can be colored to harmonize with any design and fit all pitched roofs.

Railroads that have their own concreting yards can easily install a plant of this sort, at which the manufacturing cost is said to be about $2.50 per square, including labor, material and overhead expense. The cost of laying such tile is given as $1.50 per square, making a total of $4.00 in place on the roof. This does not include the cost of paper or cleats, because this cost is common to all types of roofs and requires no comparison. Walter concrete tile are being manufactured by the Hawthorne Cement Products Company, Chicago.

A CONCRETE MIXER WITH A CONVERTIBLE DISCHARGE

It frequently happens that a mixer with an end discharge can be used most conveniently at a certain point while, if available, a side-discharge mixer is most efficient on the next job. To enable these conflicting conditions to be met with a single mixer the Waterloo Ce-

The Turntable Mixer

ment Machinery Corporation, Waterloo, Ia., has developed a mixer which can be changed from one discharge to the other by two men in less than 10 minutes without moving the mixer itself. This is accomplished merely by removing four bolts in a turntable which is mounted between the truck frame and the I-beam frame of the mixer. After turning the frame until the chute points to any one of the four sides to which it is desired to discharge, the bolts are replaced and securely tightened, after which the machine is again ready for operation. The machine is balanced on the turntable whether it is the position for side or end discharge. It has a high drum discharge and on many classes of work the material can be spouted directly into the forms, thereby saving much wheeling. This convertible feature can be applied to four models of mixers manufactured by this company.